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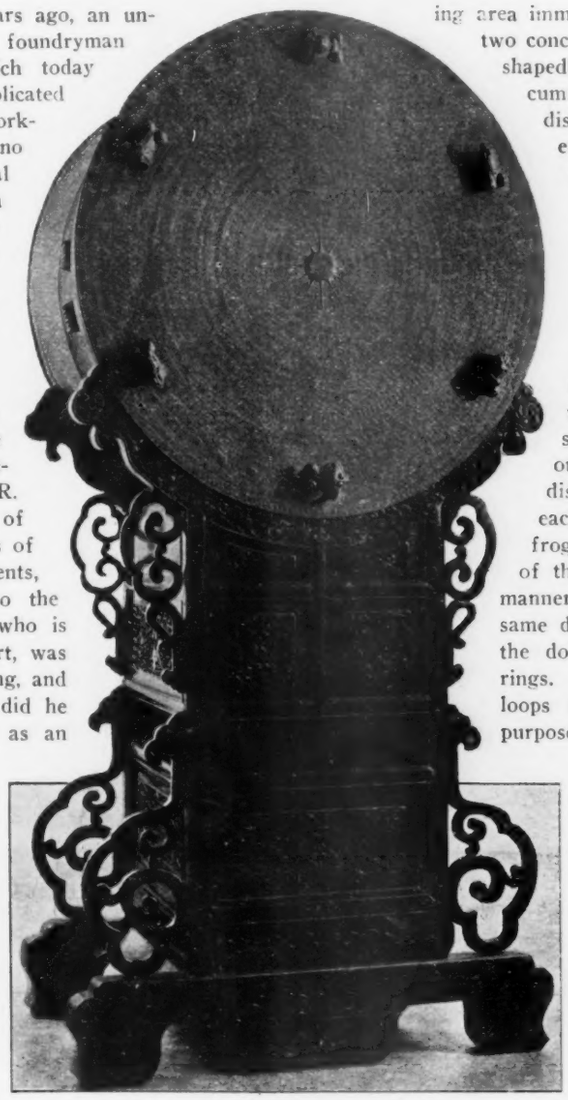
Ancient Bronze Baffles Founders

Chinese War Drum Cast at the Beginning of the Christian Era Is a Molding Enigma—Modern Cylinder Shops Would Have Trouble Duplicating This Relic

ALMOST two thousand years ago, an unknown Chinese artist and foundryman produced a casting which today probably could not be duplicated nor even imitated with success. Working with primitive instruments, no doubt with the crudest of mechanical devices and melting his metal in an open-flame, charcoal furnace, this ancient foundryman produced a work which is as inscrutable as the character of the millions who throng the Celestial Empire. That feeling of pleasure which appreciates symmetry in all things, cannot but react to the beauty of this casting which forms one of the most prized exhibits at the Cleveland Museum of Art. Worcester R. Warner, scientist, engineer and one of the world's foremost manufacturers of astronomical and precision instruments, was the donor of the casting to the Cleveland museum. Mr. Warner, who is himself an authority on Chinese art, was attracted by the beauty of the casting, and not until it was in his possession did he appreciate the value of the piece as an example of the work of ancient foundrymen. The casting is a Chinese war drum, of a peculiar form, which from a comparison with one or two other drums in this country and in China, seems to have been characteristic of a certain district in the southeastern portion of the country. The drum is circular in form, with a flat top, which extends beyond the sides as may be noted from the illustrations. The sides are curved and shaped in graceful contour, with a convex or bulging area immediately beneath the top, and with two concave portions meeting in a sharp V-shaped ridge extending around the circumference at about a third of the distance from the bottom. The lower edge is beaded to a thickness about twice as great as the shell or sides. The top is decorated by a series of 18 concentric circles, repeating at irregular intervals designs composed of small characters. These figures are in relief and stand out strongly. The center is a circular boss with radiating rays in relief. The boss doubtless was the point where the drum was struck in sounding. Around the outer circumference, spaced at equal distance are conventionalized frogs, each alternate one bearing a smaller frog upon its back. The outer surface of the shell is ornamented in a similar manner with parallel rings formed of the same designs used in the head, and with the double lines separating the different rings. On opposite sides two pairs of loops are attached, apparently for the purpose of forming supports, by which cords were attached to swing the drum with the flat surface upward. J. Arthur MacLean, curator of Oriental art at the museum, ascribes this casting to the people of the Szechman province in southeastern China, and states that various undisputed evidences place its origin at some time in the Han dynasty, which embraced the years from 202 B. C. to 220 A. D. A similar but smaller drum, described in a work on Chinese art published by the Victoria



MOUNTED ON A STAND OF GRACEFULLY DESIGNED CARVED WOOD, THE CASTING IS THE CENTER OF ATTRACTION IN THE ORIENTAL SECTION

THE INTERIOR STILL BEARS TRACES OF ANCIENT MOLDING SAND

TWO DIAMETRICALLY OPPOSITE PARTING LINES ARE APPARENT IN THE SIDES

and Albert Museum, bears the inscription beginning: "Made on the fifteenth day of the eighth month of the fourth year (A. D. 199) of the period of Chien An." The same description states that the war drums were known as Chu-ko Ku, or Chu-ko's drums after the famous Chinese general, Chu-Ko Liang, who invaded the Shan country early in the third century, one of the drums still being preserved in his own ancestral temple in the province of Szechuan. The history, and probably early service of the casting is known only through comparison with similar works which have been inscribed, or which through recorded data may be traced back to the ancient era when the bronze from which it was made was melted and cast. The physical aspects of the casting, that at once impress every foundryman present even more of an interesting mystery than its origin and history. The size, and extremely light section, coupled with the relief work in ornamentation and the attached devices on the top and sides, make the casting one which would be exceedingly difficult if not impossible to duplicate.

The flat drum-heat measures 2 feet 10¾ inches in diameter; the height, measured from the bottom, or open end to the edge is 1 foot, 8¾ inches; the diameter at the lower edge is 2 feet, 9¾ inches; and the circumference around the depression which forms the smallest section, immediately beneath the loops, is 7 feet, 10 inches. It thus may be seen that the drum is large compared with the average present day art bronze, such as vases, urns

CLOSEUP OF ONE OF THE TWO PAIRS OF LOOPS—FULL SIZE

and hollow-ware vessels of a similar nature. Yet, the average thickness of the sides and head is about ⅜ inch, and is uniform throughout as to prompt the greatest admiration from modern foundrymen. It weighs only 128 pounds.

To the artist and antiquarian familiar with ancient examples of oriental workmanship, the beauty and precision of the casting is readily apparent, and in no way surprising. The signs by which molders may analyze the way in which a casting was formed in the sand, are contradictory, and no positive evidences apparently are available to prove what combination of operations was employed.

It may be established that the drum was poured with the flat head uppermost. The marks of 30 sprues, plainly are evident, spaced at equal distances between the frogs, and directly over the sides of the drum. It is probable that a concentric row of risers was placed nearer the center or that the center boss may have been carried up through the cope. Some irregularities at intervals nearer the center seem to support this assumption. These latter are also concentric with the drum-head boss. The lost wax process may have been used in molding the drum. This theory would explain the regularity and precision of the decorative figures. However, if this method had been used, and the entire design made in the wax it is probable that the small decorative motifs would have appeared depressed in the surface of the casting instead of standing out in relief as they do.

It is not beyond belief that a cylindrical core was swept about a spindle and molded to the contour of the drum. The core then may have been coated with wax to the desired thickness and a drag, split vertically, set around it. This after ramming probably was swept level with the top of the core. Then a thin flat pattern of the top, carrying the rays emanating from the spindle was set on the cope, rammed and the sprues made. The pattern was lifted with the cope. The cope then was turned over and the pattern drawn. The wax over the sides of the core was melted and allowed to run out. The two halves of the drag were drawn back horizontally on the plate, lifted to one side, and probably again set up with a spindle or rotating shaft vertically located at the center. A marker or templet rotating on this shaft prob-

ably was used to scratch the horizontal rings which space off the different designs on the sides of the drum. The halves then doubtless were placed with the inner surface upward, and the different designs, carried on some sort of block were stamped at intervals as they appear on the surface.

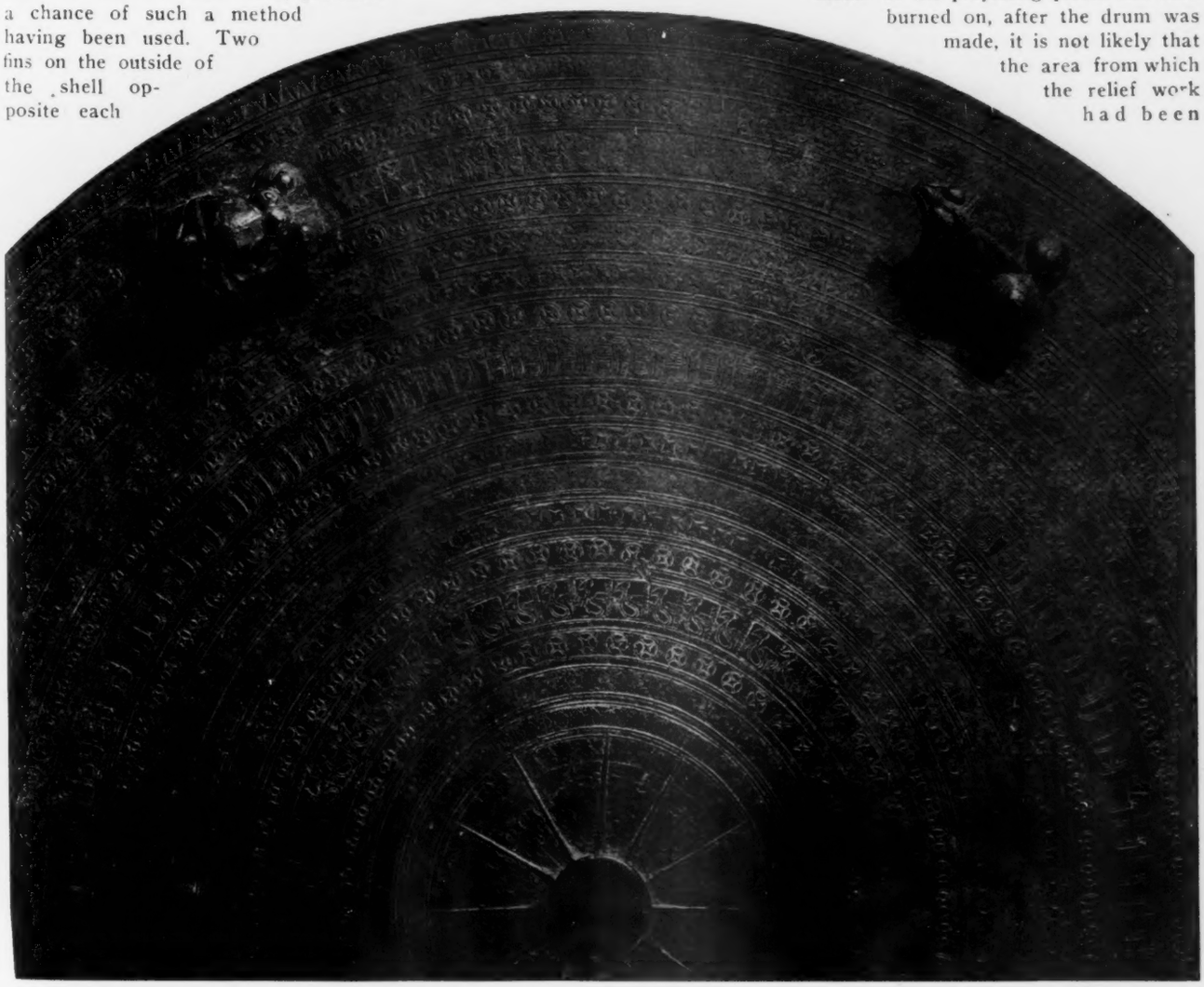
The designs upon the top probably were made in a similar manner, the concentric rings being scratched in the surface and the small characters stamped with the repeated pressure within the rings.

This theory of the method of molding has many evidences to support it, but nevertheless is weakened by some characteristics and practical considerations that seem hard to answer. The lost wax process alone could supply the exceedingly thin section of the sides, as it is almost unbelievable that the two halves of the drag could have been molded against the core, after a parting material had been applied, then drawn away, finished and put back with a spacer between the two halves. The even thickness, which from close observation does not vary by $\frac{1}{64}$ inch over the entire circumference, precludes a chance of such a method having been used. Two fins on the outside of the shell opposite each other in the sides, prove beyond question that the two halves *were* drawn back and again replaced.

That the horizontal rings, and those which separate the different circles of figures on the top, were scratched into the surface is practically proved by close examination. Traces of slight irregularities, and the variation in the weight and thickness of the lines point to this assumption as correct.

That the small decorative figures were stamped in, is shown by their irregularity of outline and the uneven spacing which might be expected were they applied in this manner. Further, the patterns often overlie the lines, and tend to prove that they were stamped in the mold after the lines had been made. Granting this theory, it is difficult to conceive of the patience which would apply these small stamps to the surface a sufficient number of times to make the thousands of impressions. On the top of the drum alone there are probably 5000 distinct marks which must have been made in this manner, and the sides doubtless carry many more. It would be interesting to know exactly how the molder maintained a surface which would take the impression of his stamping tool, or type as it was in reality, and whether after the design had been finished, the mold was baked or dried. Some traces of the molding sand remain within the drum, under a surface of soil or dust of more recent origin. The molding sand is impalpably fine. In fact it seems to the touch to be as light as modern parting dust. The color indicates a clay texture, although the sand does not leave a deposit of this material when rubbed between the fingers.

The loops on the sides, and the frogs which ornament the top have the appearance of having been cast on. In this event, they probably were contained in small cores which were set into the center of the two drag sides, and in the cope after it was finished. This theory is sustained by the smoothed areas about each of the devices mentioned, which might have been made by the molder smoothing over a joint which was made when the core was set into the surface of the mold. If the projecting pieces had been burned on, after the drum was made, it is not likely that the area from which the relief work had been



THE DRUM HEAD AND THE SIDES ARE COVERED WITH INTRICATE DESIGNS—NOTE THE UNEVEN SPACING OF SIMILAR CHARACTERS TO GIVE VARIETY

erased would have been so large. The closeup of the loop, shown on page 668, also indicates that there were lines which might have been made when the metal sought to follow the joint made by the recessed core. In further proof of the cast-in explanation, some traces of the same molding sand found inside the drum has been noted clinging to the under side of the frogs. However, the loops at the sides are clean, and show evidences of having been used to support the weight of the drum.

As was stated, the method of molding is open to dispute. Several foundrymen of wide experience who have examined the relic state that to take the two halves of the mold apart and return them again to their places surrounding the core would be beyond possibility with ancient rigging. They point out that to do this would require exact machining of the joints where the two halves came together, and also of the supporting plate. Any slight tilting of either half from the exact perpendicular would have caused the metal of the sides to have been pinched off or to have been thicker than desired. It indeed is difficult to conceive how the two parts were brought together to give an exact thickness throughout the entire circumference. Yet the Chinese invented the first astronomical instruments, several hundred years before they were conceived in European minds, and the perfection of their execution made some of them serviceable from the early thirteenth century until they were dismantled and stolen by the Germans during the Boxer uprising.

A few observations by John C. Ferguson, published by the Smithsonian institution are apropos. He states:

"In casting vessels, the ancients (Chinese) used wax for their models or patterns, and the lines were thin like hairs—even, regular and distinct. The characters were rounding like the surface of inverted tiles. They were not deep or bold and both large and small characters had the same depth. They were clear and distinct, without any blurs. Such castings of carefully chosen bronze were excellent. They had three characteristics: First, they had no marks of sand granules; second, the workmanship was wonderful; and third, there was no sparing of labor. They were not made overnight. * * *

"The sound given out by ancient bronzes is clear, while that of modern pieces is confused and noisy."

In a book by Charles Bushnell, published by Victoria and Albert Museum, the composition of bronzes during the Chou dynasty (B. C. 1122 to 249) is given from a translation of the K'ao Kung Chi, a contemporary work on the industries of the period. It is stated that during that most remote period a succession of six alloys was used, in which the proportion of tin gradually was increased from one to five, to one to one with copper. The lesser metals in the alloys are not given, as they probably existed as unknown impurities in the two main constituents. The alloy with five parts of copper to one of tin was used in the fabrication of bells, caldrons and gongs; sacrificial vessels and utensils and other cast hollow ware.

A careful analysis of the metal in the war drum at the Cleveland museum was made for THE FOUNDRY, through the courtesy of Mr. MacLean of the museum and the donor of the casting, Worcester R. Warner. Filings were taken at points which did not mar the surface. This analysis showed the following composition:

	Per cent
Copper	74.36
Lead	16.80
Iron	.14
Aluminum	.01
Antimony	.08
Zinc	trace
Tin	8.57

The high lead content is remarkable. The alloy is practically a bearing metal with 8 per cent tin and 20 per cent lead added. Although the drum antidates all knowledge of aluminum, the metal is present and doubtless had its influence upon the properties.

It may be noted from the accompanying illustrations that the drum has three breaks in the surface of the sides. None of these is an imperfection in the casting, and each bears evidence of having been caused by rough handling at some time during the centuries which have dragged by since the casting was poured. The long break, which in the view of the interior is shown to have been mended, occurred before the casting reached America, as is evidenced by the process employed in its repair. Small holes were drilled opposite each other on the two sides of the break. These were carried only part way through the shell. Sharp staples made of tin, or some other white metal of similar texture and hardness, were applied with the sharp ends set into the drilled recesses. These staples then were tapped down flush with the shell, and tended to hold the break together. It is said that a similar mode of repair is employed in mending broken pottery which is received from China.

The Shea Bronze Casting Co. 232 Fifth street, Bridgeport, Conn., is completing a new foundry and desires to purchase a small core oven, 12 x 18 and 11 x 14 iron or steel flasks, a tumbling barrel, sprue cutter, motor driven grinder, small tools and supplies.

Ladle Additions for Softening Iron

Question.—In pouring off big heats of hard iron for grates, brake shoes, bearing ribs, etc., the iron from the latter part of the heat comes down dull. We have been using the same amount of coke for the hard iron as for machinery iron mixtures. Could we use any chemical in the ladle to increase the temperature of the iron and soften it?

Answer.—We would not recommend that you put anything in the ladle to increase the temperature of the iron. High enough heat should be obtained by proper melting and we recommend that you use more coke between the charges. This will give you hotter iron. Hard iron with its low silicon and high sulphur must be melted at a higher temperature than machinery iron.

Should you desire to soften the iron by ladle additions, it could be done by adding a small amount of 50 per cent ferrosilicon and four to six pounds of 80 per cent ferromanganese to a ton of metal. These alloys should be thrown into the ladle while the stream of iron is running into it from the cupola. The amount of ferrosilicon to use will depend upon the amount of silicon in the iron, but it is impractical to add much silicon in this way. A large amount cools the iron and as ferrosilicon is lighter than iron it has a tendency to float to the top and not melt. We believe a better way to soften the iron would be to use a small amount of ferrosilicon on the charge in the cupola. The amount to add could be judged from the percentage of silicon in the mixture and then figuring the increase to be gained by the ferrosilicon addition. This would be done as follows:

Weight of metal Pounds		Per cent Silicon		Total
1000	x	2.00	=	2000
20	x	15.00	=	300
1020 divided into				2300
				2.25
Less loss in cupola				.25
Silicon in finished metal				2.00%

Requests Literature on Foundry Equipment

The Kokomo Malleable Iron Co., Kokomo, Ind., through W. C. McCoy, states that it is planning to enlarge its plants for the production of malleable castings, and that, although it is fully covered on most of its machinery needs, the company would be pleased to receive literature on a gneral line of foundry equipment. The proposed plant will be of the latest type construction, and it is expected to be ready for occupancy by the end of the year.

Cupola Practice Is Not Consistent

The Seemingly Inevitable Coke Shortage May Prove a Blessing in Disguise if It Forces Foundry Owners to Cut Down Their Coke Ratio

BY PAT DWYER

IT IS common knowledge among those engaged in the iron and steel industry that the coke production in the United States for 1920 will fall behind that for 1919 by probably 25 per cent. The production for 1919 showed a decrease of 11,651,000 tons from that of 1918 or from 56,472,000 tons to 44,821,000 tons, and conditions in general were more favorable in 1919 than they have been so far this year.

A discussion of the reasons for this shortage can be of no practical value alone inasmuch as we are confronted by a condition and not a theory and all the discussion in the world would not increase the present years production of coke. The only value such a discussion can have at this time is to help foundrymen realize that there actually *IS* a shortage of coke and that the shortage will be more acute as the year advances. Many, of course are aware of the serious situation, but it is doubtful if they are doing all that they can to conserve the fuel supply or taking any steps whereby their cupolas may be operated at a better coke to iron ratio. While it is true that no foundryman wastes coke wilfully or knowingly, still no one familiar with cupola practice will deny there is considerably more coke used than is necessary for the operation of the cupola.

Disturbed conditions in the iron and steel and railroad industry during the past year have been the principal underlying reasons for the low coke output this year. Considering the vast volume scope of the iron and steel business it is only natural that cancellation of war contracts, readjustments of prices and new credit arrangements, should first be felt at the source or fountain head, the blast furnace. The number of stacks out of blast materially affected the operations of the coke oven plants since the two are so closely linked together that what affects one is reflected in the other.

Exposure Effects Coke

A blast furnace, to be operated efficiently and on a paying basis, must be kept supplied with an adequate amount of coke, limestone and iron ore. The ore and limestone are stocked in huge piles near the furnace so that there may be no interruption in its operation. Besides the necessity for keeping a generous supply of material on hand, the blast furnaces situated in the northern parts of the United States and depending for the greater bulk of their ore supply on the deposits at the head of the Great Lakes, are forced to stock a sufficient supply during the open season to tide them over the period when lake navigation is suspended.

Exposure to the weather has no adverse effect on iron ore or limestone; it may be exposed for years and still be as good as when first dropped on the pile from the bucket. After exposure to the rain followed by a severe frost, it sometimes is necessary to employ dynamite to loosen it up for loading into the skips, but that is only a minor detail.

Coke is different. It should be handled while it is fresh. It cannot be stocked like ore or limestone because the weather *does* exert a decided deleterious influence on it, and further, it breaks up into smaller sizes each time it is handled. Coke drawn from the ovens is practically dry and hard and consists of lumps of fairly uniform size. However, when left exposed to the weather it absorbs moisture which not only promotes disintegration but also lowers its heating efficiency. A much larger quantity must be used to melt a given amount of metal owing to so much of the heat being expended in expelling the water from the coke itself. Even the most favorable

CONTRAST THE PRIMITIVE TYPE OF CUPOLA SHOWN ON THE LEFT OF THE ILLUSTRATION WITH THAT SHOWN ON THE RIGHT—IN THE FORMER THE SHELL IS MADE UP OF A NUMBER OF CAST-IRON STAVES BOUND TOGETHER WITH WROUGHT-IRON BANDS—THE MATERIAL FOR THE CHARGE IS CARRIED UP THE LADDER BY HAND AND DUMPED DIRECTLY INTO THE OPEN TOP OF THE STACK—IN THE LATTER THE MATERIAL IS CHARGED WITH A SKIP LIKE A BLAST FURNACE

TABLE I

Representative Reports on Cupolas 24 to 28 Inches Inside Diameter

Diameter in inches	Total Charge pounds	Time hours	Bed Coke pounds	Iron Charge pounds 1st charge	Iron Charge pounds others	Coke Charge pounds	Class of work	Blast oz.
24	14000	5	500	1480	980	50	converter	..
24	4500	1½	395	400	400	35	jobbing	..
27	5000	1½	260	1000	500	40	jobbing	..
28	4500	1	350	500	500	120	light	..
28	2000	½	350	1250	750	40	jobbing	..
28	2000	½	350	1250	....	150	jobbing	4
30	12000	2½	600	800	800	75	agricultural	8
30	4200	1	525	1000	800	80	light	..
30	.....	..	450	500	....	60	.....	8
30	6600	3¼	425	600	....	80	light	5
30	10000	2½	550	500	....	50	general machinery	..
32	20000	3	1000	1000	1000	125	auto	8
32	8000	2	500	1000	1000	85	jobbing	8
32	12000	2	600	1000	....	100-75-100	general	..
32	9000	4	425	6000	....	80	light	5
32	15000	1½	450	1000	....	100	gen'l machining	12
32	10000	2	500	550	....	50	gen'l machining	10
34	1200	1¼	800	2500	2000	150	jobbing	8
34	800	1½	500	1200	1200	150	jobbing	12
36	42000	6	450	600	600	80	light	12
36	18000	1	800	1000	1000	160	stoves	16
36	12000	4	900	1000	....	100	pipe & fittings	14
36	18000	1½	825	2000	....	175	machine tools	9
36	16000	1½	900	1500	....	150	textile machinery	..
36	5500	¾	460	1000	....	80	light machinery	..
36	12000	1½	600	2000	....	200	light machinery	10
36	10000	1	500	1000	....	100	machine tools	10
36	20000	2½	700	1000	....	100	gen'l machining	12
36	10000	2	800	1200	....	130	jobbing	9
36	14000	1¾	650	1600	....	65	jobbing	8
36	8500	1¼	600	1000	....	100	light machining	7
36	10000	1¼	500	1000	....	85	jobbing	8
36	42000	6	450	600	....	80	light work	12
36	21000	2½	1200	2000	....	200	jobbing	14
36	12000	1½	950	1500	1000	125	machine tools	..
36	6500	1	1025	4000	1500	250	machine tools	12
36	12000	1¼	650	800	....	80	machine tools	10
36	6000	1	400	1500	....	....	gen'l machining	12
36	7000	½	600	1000	2500	120	stove plate	13
36	16000	2½	650	1500	1000	120-100	jobbing	10
36	7000	1	600	1200	1100	100	jobbing	14
36	15000	1	600	1000	....	100	jobbing	..
36	10000	1½	720	1500	1000	120	jobbing	..
36	18000	2	800	1000	....	160	stoves	16
36	10000	2	750	1000	....	110	light	12
36	9000	1¼	750	1200	2000	125	agricultural	10
36	12000	1½	....	1500	....	.....	.....	..
36	12000	1½	1500	2000	....	150	light	16
36	19000	2	750	1500	1000	115	furnaces	..
38	7000	1¼	200	1500	1000	100	gen'l machine	10
38	12000	1½	850	1000	....	100	stoves	10
40	14000	3	1500	2000	....	340	soil pipe	8
40	36000	4½	900	2000	....	350	light work	8
40	10000	1¾	720	1600	....	170	gen'l jobbing	11
40	10000	1	1500	3500	5000	600-300	gen'l jobbing	7
40	10000	1	1000	1000	....	110	jobbing	14
40	68000	1	1000	2000	1500	200	jobbing	8
40	100000	9½	900	1125	....	180	converter	8
42	12000	1	950	2400	1200	180	gen'l jobbing	16
42	8000	1	1200	2500	....	200	light work	8
42	18000	2½	700	1000	....	100	light work	..
42	8000	1	1100	2000	....	170	gen'l jobbing	14
42	19000	2	1320	2000	....	220	gen'l jobbing	11
42	18000	1½	800	2000	1800	200	gen'l jobbing	10
42	32000	2¼	1000	1000	....	100	gen'l jobbing	..
42	20000	2	1100	2000	....	200	gen'l jobbing	..
42	12000	1¼	600	2500	....	300	machine tools	14
42	56000	9	900	1400	....	250	agricultural	10
42	42000	2½	1350	2000	....	216	gen'l machining	12
42	20000	3½	1100	2000	....	240	gen'l machining	14
42	40000	4	400	1500	....	250	gen'l machining	14
42	14000	2	1260	2000	....	260	oil engines	..
42	14000	1	800	2400	1200	125	jobbing	14
42	15000	2	720	1300	650	140	jobbing	10
42	12000	1¼	800	2000	....	160	light	12
42	10000	1	800	1000	....	85	jobbing	12
42	10000	1	700	2000	....	....	jobbing	14
42	36000	2½	600	3000	1500	300	jobbing	12
42	50000	7	1800	1500	....	150	converter steel	..
44	23000	2	950	1500	....	180	air compressors	14
44	32000	2¼	1350	2000	....	210	light work	16
44	15000	1½	1200	2000	....	220	light work	18
44	13000	1½	1000	3000	1500	150	light work	10
44	18000	1½	1200	1500	....	130	gen'l machining	..
44	24000	1¾	825	2500	....	200	light	9
44	25000	2	1100	2000	1500	150	heavy mach'n'g	16
44	25000	1½	600	2000	....	200	jobbing	8
44	20000	1¾	1200	2000	1700	160	stoves	12
44	36000	2½	1500	2000	....	200	light	16
44	32000	2	1500	2000	....	200	light	13
44	24000	2	1000	2100	....	300	light	10
44	12000	1½	900	1000	....	90	light	16
46	38000	2½	850	2500	....	120	light machinery	..
46	30000	1¾	1000	1200	....	150	machine tools	10
48	40000	2½	1600	3000	....	300	jobbing	12
48	50000	4	1500	2000	....	300	auto engines	17
48	60000	4	1800	3000	2000	300	jobbing	12
48	20000	2½	1500	2000	....	220	machine tools	..
48	48000	3	1900	3000	....	315-280	light	..
48	40000	2	1800	2000	....	200-200	jobbing	13
48	20000	1¼	1200	2000	....	290 (150) last	light	..
48	18000	1½	1900	4000	2000	200	jobbing	10
48	7500	1	850	2000	1500	200	jobbing	8
48	48000	3½	1500	3000	1700	230	heavy	12
48	30000	2	2400	6000	3000	400	heavy	13
48	30000	1½	1100	1000	....	130	light	11
48	40000	3	1800	3000	2500	500	heavy mach'y	11
48	58000	5	2000	4000	....	250	gen'l jobbing	15
48	22000	1½	1700	2100	....	350	light work	11
48	40000	2	2000	2000	....	200	light work	14
48	12000	1¼	1000	2000	....	300	stove plate	14
48	20000	2	800	1000	....	100	pumps	..
48	20000	1	1400	2000	....	250	agricultural	12
48	30000	1¾	1200	2000	....	220	gen'l machining	12
48	15000	1½	1200	2000	....	240	gen'l machining	10
48	14000	1	1350	2200	....	225	engines	10
48	50000	2½	1500	2000	....	300	railroad castings	..
48	20000	1½	1200	2500	2000	150	gen'l machining	10
48	30000	2¼	1200	2500	2000	250	pumps	14
48	30000	1¾	1400	2000	....	200	jobbing	16
48	96000	5	1800	1500	....	175	converter steel	15
48	75000	1	800	1500	....	160	gen'l jobbing	..
48	18000	1¾	1350	3000	....	300	gen'l jobbing	12
48	24000	1¼	1600	3500	2000	200	light work	14
48	40000	2½	1700	2000	....	200	agricultural	8
48	12000	1	1200	2000	....	200	heavy mach'n'g	16
52	16000	1	1700	5000	....	650	jobbing	16
52	88000	4	2600	4000	....	400	valves	14
52	50000	2½	1600	3500	....	400	soil pipe	8
52	24000	1½	1500	3000	....	300	jobbing	..
53	15000	1½	550	1000	....	102	pumps	14
54	36000	3½	1900	2800	....	200	machinery	14
54	50000	2½	2400	2000	....	250	machinery	12
54	20000	1½	1250	2300	....	230	light work	14
54	40000	2	1750	3000	2000	310	light work	14
54	60000	2½	2000	4000	....	420	gen'l machining	..
54	50000	2½	2400	2000	....	250	gen'l machining	12
54	34000	2	1400	3000	....	400	furnaces	..
54	45000	2	1200	5500	5000	580	light work	16
54	50000	2½	1700	3000	....	450	sanitary ware	12
54	46000	3½	1550	3000	....	300	gen'l machining	10
54	90000	3½	1500	1500	....	150	mining mach'y	6
54	60000	3	1700	2000	....	250	agricultural	8
54	36000	2	1600	4000	....	400-300	machining	14
54	21000	1½	2000	3000	....	350	gen'l machining	14
54	30000	1½	1800	3000	....	200	light	..
54	29000	1¾	2000	2400	....	230	jobbing	10
54	33000	1¾	1700	2000	....	180	stoves	14
54	45000	2¼	1400	1500	....	160	light	12
54	43000	3	1750	3000	....	370	heavy	12
54	19000	1½	1400	4000	3000	400	light	10
54	30000	2	2000	2400	....	240-400	gen'l machining	11
54	15000	8	2100	2400	....	250	light	16
54	38000	2	1400	2000	....	220	light	..
54	18000	1	1900	4000	....	500	light	10
54	65000	2½	1600	4500	3000	300 (275) last	heavy mach'n'g	14
54	75000	3	2700	3000	....	280	light	18
54	75000	4	1400	2000	....	225	radiators	13
54	24000	2	2000	3400	2400	250	jobbing	12
56	40000	1⅜	1000	2500	....	300	light	14
56	60000	2	3200	3000	....	300	radiators	12
56	60000	3	1600	4000	....	400	gas engines	..
56	100000	4½	2100	3500	....	350	gas engines	..
56	120000	5	2500	3000	....	300	textile mach'y	12
56	106000	7	2800	4000	3000	400	water pipe	7
56	12000	1	1700	4000	....	450	gen'l machinery	16
60	49000	2½	2400	4000	....	400	textile mach'y	14
60	70000	2	2200	3000	....	300	agricultural	8
60	18000	1	1700	4000	....	450	gen'l machinery	16
60	46000	3	2250	4000	....	400	gen'l machining	14
60	50000	2	2200	7000	....	650	machine tools	16
60	30000	1	5100	8000	....	900	chilled rolls	16
60	80000	4	3000	5000	4000	900	rolling mill	10
60	80000	3½	2600	5000	4000	600	soil pipe	12
60	75000	3	2400	3000	....	300	gen'l machinery	16
60	48000	3	2500	4000	....	500	soil pipe	10
60	40000	2¼	2000	4000	....	600	gen'l jobbing	13
60	16000	1	2100	4000	....	700	gen'l jobbing	8
60	60000	3	2000	2600	....	320	light work	14
60	60000	3	2000	3000	....	300	heavy mach'y	14
60	32000	1¾	1400	2000	....	225	stove plate	15
60	32000	2	1400	1000	....	250	gen'l machinery	..
60	80000	3	2000	4000	....	450	soil pipe	..
60	22000	2	2300	4000	2000	400-375	stoves	12
60	70000	3	2000	4200	....	500	soil pipe	10
60	37000	1⅝	2000	3200	....	400	stoves	12
60	45000	4½	1200	1000	....	200	auto engines	..
60	10000	1	1000	2000	....	250	stoves	16
60	40000	2	2000	4000	....	400	jobbing	14
60	60000	2½	2300	4000	3000	330	stoves	..
60	36000	1½	1800	2500	....	300	light	..
60	64000	3½	2100	4000	2000	320-240	light	14
60	33000	2½	1850	2500	....	240	light	8
60	38000	1½	2000	2000	....	245-210	stove	12
60	50000	7	1000	2000	....	200	converter	..
60	30000	1⅔	1850	3300	....	400-200	jobbing	12

(*Concluded on page 674*)

A TYPICAL INSTALLATION IN A FOUNDRY MAKING CONVERTER STEEL CASTINGS—NOTE THE HIGH WIND BOX ON THE CUPOLA TO THE RIGHT

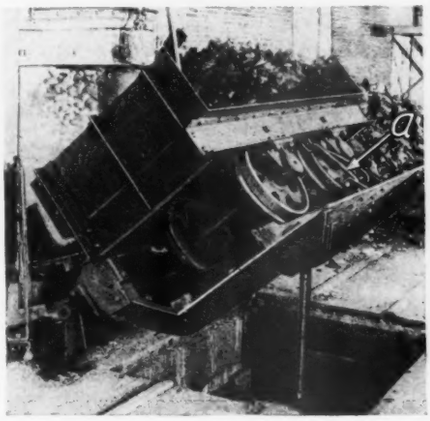
conditions where a blast furnace company operates its own coke ovens and ships the coke direct to the furnaces where it is used every day, a considerable amount of fine coke or breeze is developed, which is harmful in either furnace or cupola.

Railroad Snarl Responsible

Another reason why blast furnace plants do not stock coke is on account of the extremely high prices prevailing at the present time. Blast furnace operators know that there is a certain approximate relation between the price of coke and the price of iron and when the price of coke exceeds that figure they know they cannot produce pig iron at a profit. To cover existing contracts many blast furnace plants have been forced to buy spot coke in the open market recently and none of them feels like entering into long term contracts at the present price.

The coke oven plants do not maintain stock piles. The principal reason for this being that coke which has been exposed to the weather is not looked upon with favor either by iron producers or foundrymen. Even if that reason were not present, few coke oven plants have the yard area in which to store up great quantities of coke and if they had the space, the extra time and labor involved in conveying and handling the coke so many times would add materially to its cost.

The nation-wide shortage of cars and general snarl in which the railroads of the country are involved also have a direct bearing on the coke situation. The mine operators claim that they cannot secure enough cars to keep their mines working to capacity. The coke men say that coal which should come to them is diverted into other channels and therefore they cannot make enough coke to supply even a limited demand. The feature of the car situation which hits the coke men hardest is that they can get no definite assurance as to what time empty cars will be assigned them and further, they must accept the cars when they do arrive whether they are ready for them or not, and the cars will be taken away again after 24 hours, irrespective of whether they are loaded or not.



A SECTION OF THE CHARGING FLOOR IS MOUNTED ON TRUNNIONS—A CLAMP PREVENTS THE CAR FROM FALLING OFF

The last rule may be the means of having a car cover a certain designated area in schedule time and conform to a carefully thought out plan which embraces the movement of a fleet of freight cars, but its efficacy in relieving the congested freight situation is extremely doubtful when it is remembered that about half the time these same cars may travel light on account of the freight at some points on their journey not being ready the minute the cars were spotted.

This practice of spotting cars at unexpected time and snatching them away again at a given time whether they are loaded or not has further tended to embarrass the coke-oven men. The temptation to load 30 and 36-hour coke is strong, if a string of cars is run into the plant when the ovens are at that stage. If the operators refuse to accept the cars and keep the coke in the ovens for the full 72-hour period, they run the risk of not being able to get any cars when they are ready to load them. If they accept the cars and load them with fuel that has not been thoroughly "coked" they are instigating a series of annoying experiences for the blast furnace or foundry which receives the coke.

Uninterrupted Operation Imperative

If ever a body of men were between the devil and the deep sea it is the coke oven men in this present year of grace. To operate a coke oven plant with any degree of success it is essential that there be a steady and uninterrupted flow of coal arriving on one side and a steady flow of coke leaving the other. Anything which tends to interfere with either

TO OBVIATE HANDLING THE COKE A SECOND TIME IT IS DUMPED DIRECTLY FROM THE WHEELBARROWS INTO THE CHARGING DOOR

TABLE I

Representative Reports on Cupolas 24 to 28 Inches Inside Diameter

(*Concluded from page 672*)

Diameter in inches	Total Charge pounds	Time hours	Bed Coke pounds	Iron Charge pounds 1st charge	Iron Charge pounds others	Coke Charge pounds	Class of work	Blast oz.
64	150000	7½	3200	5200	....	520	car wheels	8
64	80000	3½	2200	4500	3100	365	heavy	12
66	40000	1½	6000	9000	....	1000	heavy mach'y	10
66	135000	7	3600	4500	3500	420	cast iron pipe	8
66	110000	8	3200	3000	....	550	automobile engines	16AR
66	60000	2½	2000	5000	4000	350	light work	15
66	70000	2½	3000	3000	2500	400–325	stove plate	14
60	100000	6½	3000	8000	4000	500	{loco- 12—350 coke motive 150 Hcoal	
66	28000	1½	2500	5000	....	500	jobbing	10
66	45000	2½	2500	2000	....	200	stoves	14
66	100000	4½	3300	6000	5000	600	jobbing	14
66	80000	3½	2520	7500	5000	560	light	12
66	54000	2	1625	4000	....	550	light	14
66	44000	2½	2850	4000	2000	375	light	9
66	40000	1¼	2400	6000	4000	600	jobbing	16
72	200000	6½	4500	5600	....	560	car wheels	8
72	175000	6	3900	5600	....	560	car wheels	8
72	50000	2½	3000	8000	4000	275	heavy	14
72	100000	2½	7700	10000	....	1700	heavy mach'y	16
72	335000	10	4000	8300	....	800	car wheels	8
72	120000	4	2600	10000	....	1000	machine tools	16
72	100000	5	2800	2500	....	280	gas engines	16
72	130000	5	3000	4500	....	550	automobiles	16
72	86000	3½	4200	6000	....	600	gas engines	10
72	50000	1½	3800	2000	....	240	agricultural	15
72	60000	3	2400	5000	....	500	heavy mach'y	10
72	100000	4	2250	2500	....	500	agricultural	8
78	220000	8	6600	6000	....	775	car wheels	8
78	110000	3½	2650	4000	....	324	pipe fittings	..
78	220000	8	4500	6000	....	1100	automobiles	16
78	112800	3	4200	6800	....	680	light	18
78	430000	12	5000	6800	....	680	car wheels	8
84	100000	3	4500	10000	9000	1000	jobbing	16

of these operations will make trouble. When the ovens are drawn it is necessary to have cars available to haul the coke away. It also is necessary to have a supply of coal on hand so that the ovens may be recharged without loss of time. The uncertain railroad service is not conducive to these conditions and as a result the coke men are handicapped seriously in their efforts to meet production schedules or to fill their orders.

THE FOUNDRY on several occasions recently has directed attention in its editorial columns to this anticipated and seemingly inevitable shortage of coke this winter, and has urged foundrymen to check up their cupola practice with a view toward fuel conservation. Considering the present almost prohibitive price of coke any advice or comment might seem superfluous; but anyone who is practically intimate with cupola operations in this country knows that the majoirty of foundries conduct this vital branch of their business in a more or less indifferent manner.

The superintendent or foreman issues instructions to the cupola man covering the proportions of iron and coke to be used and then promptly dismisses the matter from his mind. The cupola man frequently has ideas of his own and institutes changes both in the height of the bed and the relative weight of coke and iron in the charges, sometimes with, but more often without, the formality of consulting either foreman or superintendent. So long as the metal is satisfactory to pour, the latter is not particularly interested. The original charging sheet is retained in the office and the clerk fills out a duplicate every night for the advice of the cupola man. The latter signs it, hangs it on a nail and pays no more attention to it. He charges the cupola according to his own judgment and is willing to tell the world that if he ever quits, the company will never be able to replace him.

This is not universal practice. Many foundries are supervised by competent men who know how to melt iron in the most efficient and economical manner. They not only know how to do it but they can instruct their cupola men, and more important than all else, they arrange to spend enough of their own time on the charging floor each day to see that instructions are carried out. This is as it should be. The cupola is the heart of the foundry and if the metal is not melted prop-

TABLE II

Maximum and Minimum Reports on Cupolas 24 to 28 Inches Inside Diameter

Diameter in inches	Total Charge pounds	Time hours	Bed Coke pounds	Iron Charge pounds 1st charge	Iron Charge pounds others	Coke Charge pounds	Class of work	Blast oz.
24	14000	5	500	1480	980	50	converter	..
24	4500	1½	395	400	400	35	jobbing	..
28	4500	1	350	500	500	120	light	..
28	2000	½	350	1250	750	40	jobbing	5
30	12000	2½	600	800	800	75	agricultural	8
30	4200	1	525	1000	800	80	light	..
32	20000	3	1000	1000	1000	125	auto	8
32	8000	2	500	1000	1000	85	jobbing	8
34	12000	1¾	800	2500	2000	150	jobbing	8
34	8000	1½	500	1200	1200	150	jobbing	12
36	42000	6	450	600	600	80	light	12
36	18000	1	800	1000	1000	160	stoves	16
38	12000	1½	850	1000	1000	100	stoves	14
38	7000	1¼	500	1500	1000	100	jobbing	12
40	36000	4½	900	2000	2000	350	light	8
40	6800	1	1000	2000	1500	200	jobbing	14
42	50000	7	1800	1500	1500	150	converter*	..
42	8000	1	1200	2500	2500	200	light	8
44	36000	2½	1500	2000	2000	200	light	16
44	25000	1½	600	2000	2000	200	jobbing	8
46	30000	1¾	1000	1200	1200	(400 on 150 10th chg)	machine tools	10
46	16000	1¼	1200	2000	2000	200	jobbing	12
48	96000	5	1800	1500	15000	175	converter	..
48	20000	1¼	1200	2000	2000	300	light	..
52	88000	4	2600	4000	4000	400	valves	14
52	15000	1½	550	1000	1000	102	pumps	14
54	90000	3½	1500	1500	1500	150	mining machinery	6
54	21000	1½	2000	3000	3000	350	jobbing	14
56	120000	5	2500	3000	3000	300	textile	12
56	40000	1⅝	1000	2500	2500	300	light	14
60	70000	2	2200	3000	3000	300	agricultural	8
60	50000	7	1000	2000	2000	200	converters*	..
64	150000	7½	3200	5200	5200	520	car wheels	8
64	80000	3½	2200	4500	3100	365	heavy	12
66	135000	7	3600	4500	3500	420	cast iron pipe	8
66	40000	1½	6000	9000	9000	1000	heavy	16
72	335000	10	4000	8300	8300	800	car wheels	8
72	120000	4	2600	10000	10000	1000	machine tools	16
78	430000	12	5000	6800	6800	680	car wheels	8
78	110000	3½	2650	4000	4000	325	pipe fittings	..
84	100000	3	4500	10000	9000	1000	jobbing	..

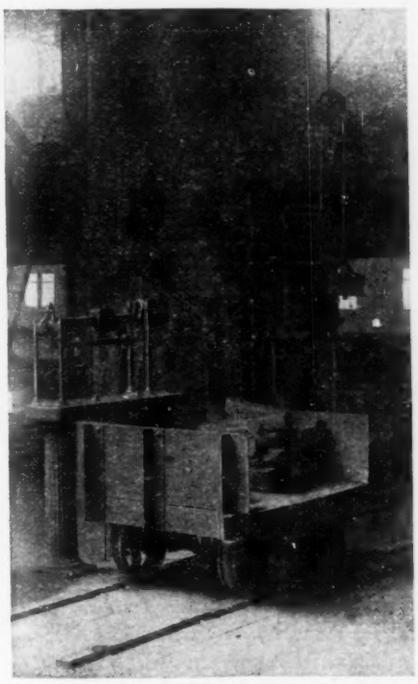
erly the most perfect supervision over the other departments simply is wasted effort.

With a view to showing the widely divergent opinions held by men who melt iron in cupolas, THE FOUNDRY sent a questionnaire to over 600 foundries located all over the United States and Canada and manufacturing all classes of castings. The tabulated returns from 231 are shown in Table I. While not by any means a complete list, this is fairly representative and probably reflects American cupola practice as truly as it would did it comprise reports from every foundry in the country.

Medium Sized Cupolas Popular

An interesting feature of this investigation, though without any bearing on the coke situation, is that approximately 60 per cent of the total tonnage of gray iron is melted in 36, 48, 54 and 60 inch cupolas. The remaining 40 per cent is divided up among 18 different sizes, ranging from 24 inches inside diameter to 84 inches which was the largest size cupola from which a report was received.

Many of these reports indicate that



THE CHARGING CARS PASS OVER A SCALE SITUATED CLOSE TO THE CHARGING DOOR

the practice in these particular shops could not be improved. Several were accompanied by supplementary letters which showed that the writers were in close personal contact with the melting conditions in their respective shops and fully alive to the importance of keeping accurate records. Others again indicated only indifferent practice, while a sufficient number were so palpably sheer guess work that they helped to bear out the statement made a little earlier in this article that haphazard methods prevail to an astonishing degree.

For obvious reasons no names are given and it is quite probable that the authors will not recognize some of these figures when they see them again. Among the statements which challenged attention and which is not published it one to the effect that the writer is melting 14,000 pounds of iron an hour in a 30-inch cupola. Another claimed to be using a 1600 pound charge of iron in a 34-inch cupola, which of course is not extraordinary, but when he set down 65 pounds of coke as the amount he used between the charges, it must be admitted that if every one were like him there would be no need to worry over a coke shortage, now or at any other time.

Table I shows the returns just as they were received and grouped according to cupola diameters. The second table is made up of minimum and maximum reports; two reports for each size of cupola, the contrasting reports being based on the amount of iron melted at each heat. Table III is prepared in accordance with the results of numerous tests conducted by competent authorities and represents what may be considered standard American cupola practice.

One important factor and one which has a direct bearing on the relative height of the coke bed; viz: the height of the tuyeres, was omitted from most of the reports received. In fact this point was touched upon by such a comparatively small number of foundrymen that it was of no value as a basis of comparison. Another point on which there appeared to be a considerable amount of misapprehension was in regard to the proper manner of indicating the elapsed time required to melt the heat.

A few foundrymen indicated that the time included from the minute the wind went on until the bottom dropped, which of course is the proper way, if one is to draw any accurate conclusions in regard to the melting speed of any two given cupolas operating under apparently similar conditions. Two cupolas may melt at the same speed after the metal appears at the tap-hole, but the one may have been in blast anywhere from 5 to 20 minutes longer than the other before the first iron appeared.

It is an established fact that the incandescent zone in a cupola is located at a definite point above the tuyeres and consequently the iron charged on an exceptionally high bed, that is, a bed extending to an exceptional height above the tuyeres, will not melt until the coke has been burned away sufficiently to bring the iron down to the melting zone.

From the foregoing it readily will be apparent that although two cupolas of the same inside diameter may carry the same amount of coke on the bed, the cupola with the high tuyeres, which in this case means the tuyeres

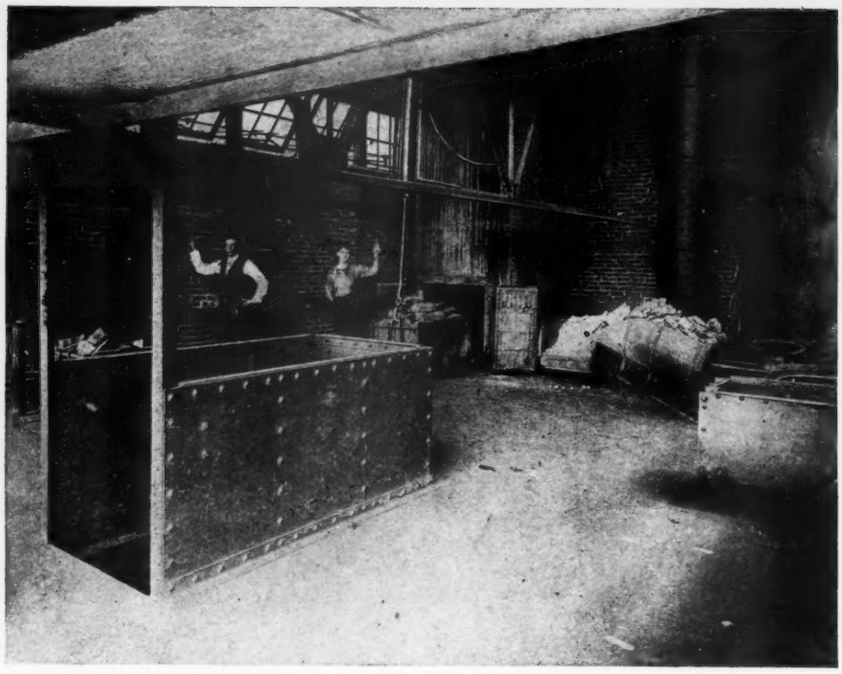
PANS AND COKE CANS ARE LOADED IN THE STOCK YARD AND DEPOSITED ON A LANDING COMMUNICATING WITH THE CHARGING FLOOR

nearest the top of the coke bed will require a shorter time to bring down the initial charge of iron than the cupola in which the tuyeres are located closer to the bottom. However, it must be remembered that if the coke bed were lowered to the same relative height above the low tuyeres, the iron would melt just as fast and at a material saving of coke.

Locate Tuyeres Low

The lesson to be drawn from this is that the tuyeres should be located as low as is consistent with the amount of iron to be held in the cupola before each tap. This practice will result in a correspondingly low bed. This fact will be better appreciated when it is remembered that the amount of coke *below* the tuyeres has absolutely no bearing on the heat of the iron nor on the speed of melting.

As already pointed out the melting takes place at a certain definite point *above* the tuyeres, that point depending on the quality of the coke and the pressure and volume of the blast. The first iron should appear at the



THE IRON CHARGES ARE DUMPED BY AN AIR HOIST; BUT THE COKE BUGGIES ARE DUMPED BY HAND

tap hole about 8 minutes after the wind goes on. If it does not appear in that time it will pay to make an investigation. It may be that the coke bed is the correct height but the blower is not delivering sufficient quantity of air.

Approximately 30,000 cubic feet of air are required to melt one ton of iron. A cupola should melt about 10 pounds of iron an hour for every inch of horizontal area at the tuyeres. With these two factors it is a simple calculation to find how much air should be delivered into any size cupola in a given time. If the blower is not delivering the required volume of air it should be attached to a more powerful motor; while on the other hand, if an investigation discloses that it is delivering air up to its capacity it should be replaced by a larger unit. If it is found that the blower is delivering a sufficient quantity of air for the rated melting capacity of the cupola then it is apparent that the coke bed should be lowered. After the cupola has been in blast for some time there is a possibility of miscalculating the volume of blast entering into it on account of the tuyeres partially closing; but there is no obstruction for at least half an hour after the wind goes on and any observations made during that time are likely to be accurate. In these days, when coke is both scarce and high, a difference of 6 inches in the height of the bed will mean anywhere from $1 to $10 a day, depending on the size of the cupola and a corresponding saving in the total amount of coke necessary for the daily operation of the cupola. The same rule also applies to the amount of coke used between the charges. A ratio of 1 to 10 long has been regarded as good melting practice and only possible when good coke is available. There is no economy in skimping the coke if the character of the castings, the distance the molten iron has to be conveyed, or the number of times it must be rehandled demands superheated metal at the cupola spout. Foundries engaged in the production of light work and those specializing in castings for the automotive industry claim it is necessary to employ a ratio of 1 to 5 or 6.

Among the many points of difference shown in the 36-inch cupola reports perhaps the most remarkable is that between two which report the same amount of coke on the bed, 700 pounds, the same weight of iron and coke charges, 1000 pounds of iron and 100 pounds of coke. The similarity between the two ceases with these factors. The first report shows that 20,000 pounds of iron were melted in 2½ hours; or at the rate of 8000 pounds per hour. The second report indicates that it required 2 hours to melt 10,000 pounds or only about 5000 pounds an hour.

One 48-inch cupola is shown as melting 20,000 pounds an hour; while a second admits to 7500 pounds and between these there are reports indicating 12,000, 14,000, and 16,000 pounds as the amounts melted hourly.

Reading this article will be of no particular value to the man who already is operating on an efficient basis. However, it should prove both of interest and value to the great majority of foundrymen for as the report indicates, there is a sad lack of unanimity in cupola practice. Reference to the man who is operating his cupola at the highest point of efficiency does not mean the one whose shop records show the greatest economy; but rather the man who knows from actual observation that these

THIS FOUNDRY IS BUILT ON THE SIDE OF A HILL; THE STOCK YARD IS LEVEL WITH THE CHARGING FLOOR—COKE IS LOADED INTO A POCKET ON THE ROOF AND IS DISCHARGED ONTO THE CHARGING FLOOR BY GRAVITY

TABLE III
Relative Charges of Coke and Iron

Diameter in inches	Area feet	Bottom of tuyeres	Height of bed	Coke in pounds	Coke charge	Iron charge	Pounds per hour
24	3	6	3′ 3″	280	60	600	4,323
30	5	8	3′ 6″	490	100	1000	7,068
36	7	10	3′ 8″	718	140	1400	10,178
42	9½	12	3′ 10″	1020	190	1900	13,854
48	12¾	14	4′ 2″	1488	250	2550	18,095
54	16	16	4′ 4″	1932	320	3200	22,902
60	19½	18	4′ 6″	2457	390	3900	28,274
72	28	20	4′ 8″	3612	560	5600	40,714

records are correct and correspond to actual conditions. There is no department around a foundry in which actual and assumed conditions may differ as widely as they can around the cupola; and broadly speaking, there is no department which receives as little attention.

A cupola will function satisfactorily under a wide range of conditions and that is the principal reason why so many foremen are averse to experimenting with a view of finding the ideal condition. They act on the principle that it is best to let well enough alone. Of course, when a new cupola is installed during a foreman's tenure of office he probably will experiment more or less, depending on his initiative, before he makes out an arbitrary charging card. However, in the great majority of cases, the cupola and the charging practice antedate the foreman and as long as the iron comes down good and hot, he does not worry how it is done. In many instances any tendency on the foreman's part to change long established melting practice, is frowned upon by the management.

Too Much Coke Charged

The only time the foreman interviews the melter is when the iron happens to come down dull. Now dull iron may result from any one of several causes, but as a general rule no investigation is held. It usually is blamed on the amount of coke used. Applying the principle that if a small lemon is sour, a big one should be sourer, additional coke is used on the following day. It may happen that the conditions leading up to the dull iron are not present on this occasion and, as the additional quantity of coke does not make the hot iron any hotter therefore the amount of coke is left at the advanced figure and becomes the established practice. When this happens a few times, there is practically twice as much coke going into the cupola as is needed and any attempt to reduce it is viewed with horror by the melter who is sure that if the iron does melt, of which he is doubtful, it will be too cold to use.

Castings may be hard or soft, strong or weak, smooth or rough, dirty or clean and no one thinks of speaking to the melter about it; but if the iron is dull he receives all the blame. Then, it is only natural that he should concentrate on that one point and disregard everything else in his endeavor to supply iron that will smoke in the ladle.

Hot iron is a prime necessity in the foundry and it would indeed be false economy to reduce the coke ratio to a point which would not produce iron of the proper temperature, but there are such things as *enough* and *too much*. Every foundryman who has supervision over a cupola should exercise that supervision in a practical manner and satisfy himself by study, observation and investigation that his practice really is efficient, and having satisfied himself he should see to it that the practice is rigidly adhered to. A certain elasticity should be allowed on the charging card to provide for variation in the quality of the coke and for any abnormal change in the size of the pig iron or scrap, but otherwise the charges should be kept uniform and within rigid limits.

Cupola Charging Not Guess Work

In the past, when charging a cupola was all a matter of guess work, every cupola constituted a problem to itself, but in recent years the problem has been investigated so thoroughly by so many competent authorities and the result of their findings so widely disseminated that there really is no valid excuse for foundrymen pursuing the wasteful policy which

A SMALL PORTABLE CUPOLA—THE CUPOLA IN A STOVE SHOP IS PLACED IN THE CENTER OF THE BUILDING

many of them are doing. This is particularly true at the present time when every effort should be made to conserve coke.

A certain amount of experimenting may be necessary to determine the highest point of efficiency at which any individual cupola may be operated; but several broad, general principles have been established and are shown in Table III. In addition to the examples shown, the following rules are submitted for the guidance of those who wish to do their own calculating.

A cupola should melt 10 pounds of iron per hour for each inch of area at the melting zone.

The area of any circle is found by squaring the diameter in inches and multiplying the result by 0.7854. For example, a cupola 36 inches in diameter would have an area of (36x36) x 0.7854 or 1017.85 inches. Thus, by applying the foregoing rule, such a cupola should melt 1017.85 x 10 or 10,178.5 pounds of iron an hour.

Coke weighs approximately 28 pounds per cubic foot and for that reason it will be necessary to reduce the area to square feet and multiply by the height, also in feet. The height of the tuyeres will determine the height of the bed and therefore as a measure of economy the tuyeres should be placed as low as possible. Special conditions may make it necessary to provide exceptionally low or exceptionally high tuyeres. The former condition is met in shops where the iron is allowed to run in a constant stream and the latter where a maximum amount is gathered before tapping as in cupolas operated in connection with bessemer converters and heavy-work foundries. The average height of tuyeres for cupolas between 24 and 72 inches inside diameter, is given in Table III.

Limit Height of Bed

With exceptionally good coke, a bed 24 inches above the tuyeres will produce satisfactory iron; but with coke of uncertain quality it may be necessary to carry the bed to a height of 30 inches. If it should be necessary to carry the bed higher than 30 inches above the tuyeres, it is an indication that something is radically wrong.

Cold iron at the first of the heat frequently is blamed on a low bed when in many cases it should be ascribed to a hard or wet bottom; wet lining or a bed not burned up properly.

With the foregoing data, the weight of coke for the bed of any diameter cupola readily can be calculated. Multiply the area of the cupola in feet by the height of the required bed, also in feet and then multiply the result by 28. This will give the result in pounds. Using the former illustration, it is noted that a 36-inch cupola has an area of 1017.85 square inches. Dividing this by 144 the area is found to be 7 square feet. The top of the tuyeres in the average 36-inch cupola will be 14 inches above the sand bottom, and an additional 30 inches for the bed would give a total height of 44 inches, or 4 2/3 feet. Therefore, to find the weight of coke necessary for the bed it only is necessary to multiply 4 x 4 2/3 x 28 which is equivalent to 718 pounds.

Bed Charged by Volume

Some kinds of coke are heavier than others bulk for bulk and where there are no facilities for weighing the coke readily every day, the bed can be charged by volume. Having determined the most satisfactory height at which the cupola operates, probably between 24 and 30 inches above the tuyeres, a light iron rod may be bent at one end and lowered inside the cupola until the long toe on the end rests on the coke. The other end then is bent in the opposite direction, the whole rod resembling the letter Z, one end resting on the coke and the other end resting on the sill of the charging door. This rod may be used as a gage in charging by volume.

Whether the coke is weighed or measured, enough to form a layer approximately 4 inches thick should be held in reserve and added after the bed has burned through. The air inlets in the wind box then should be closed and the cupola filled to the charging door.

Probably there is more divergence of opinion among foundrymen over the proper weight of the charge than over any other feature of cupola operation. A glance at the figures in Table I will show that practically no two of any given size cupolas are charged alike. The majority have one feature in common; their charges are uniform throughout the duration of the heat. It is the custom in some shops to make the first charge heavier than the others, in some cases twice as heavy; but the benefit is problematical from an economical standpoint, since it is necessary in such cases to increase the amount of coke on the bed by practically the same amount as would have been required if the charge had been split in two and coke used between.

The following rule may be employed to find the approximate weight of iron and coke to use in charging a cupola. Multiply the area of the cupola at the melting zone in square feet by 200 which will give the result in pounds of iron; the coke may be figured from that in the ratio of 1 to 10. For example, the area of a 36-inch cupola is 7 square feet; 7 x 200 is 1400, the weight of the iron charge. This at the indicated ratio of 1 to 10 will give a coke charge of 140 pounds.

Summing up, it may be said that the height of the tuyeres exert no influence on the heat of the iron, hot iron can be melted whether the tuyeres are high or low, but in the interests of economy and unless it is necessary to hold a considerable amount of iron before tapping, it is advisable to have the tuyeres as low as possible. Light, thin charges of iron and coke will produce hotter iron than thick, heavy charges, but they should be made as heavy as the cupola will stand without affecting the quality of the iron.

Heretofore coke has been cheap and plentiful and always available whether in winter or summer. As a consequence, the average American foundryman has grown up to regard it carelessly. A barrowful or two extra on the bed was immaterial and four or five extra forkfulls on each charge; "to see if the old man would stop his growling about cold iron;" was considered ordinary practice. Furthermore, with a passion for neatness and tidiness which characterizes some people at the most inopportune times, the stage would be cleaned up at night by pitching all the remaining coke into the cupola.

The constantly soaring prices and the growing scarcity of coke at any price are influencing foundrymen more and more to give intensive and minute attention to their cupola practice. Even by the most rigid economy, it is extremely problematical at the present writing whether all foundries will be able to operate throughout the coming winter.

Historic Foundry Sold

The historic West Point Foundry, Cold Spring, N. Y., which closed down a few years ago after the A. B. & J. M. Cornell Iron Works had operated it for several years, has been sold to the Astoria Silk Mills, Astoria, L. I., according to announcement. The silk mills firm will operate the foundry with 700 employes.

The first locomotive used in New York state, the old wood burner De Witt Clinton, was constructed at the West Point plant. In the civil war the plant was rushed with orders. Hundreds of Parrot guns were made.

SPECIFICATIONS FOR CAST-IRON SOIL PIPE AND FITTINGS*

I.—Manufacture

1. The cast iron from which the pipe and fittings are made shall be of such composition, and the conditions of manufacture so maintained, that the castings will be of uniform physical character, close-grain, and not hard, brittle nor difficult to cut with file or chisel.

2. (a) When pipe or fittings are to be coated, coal-tar pitch shall be used, which shall contain sufficient oil to make a smooth coating. The pitch shall be tough and tenacious when cold, and not brittle nor having any tendency to scale.

(b) The varnish shall be heated to about 300 degrees Fahr. and shall

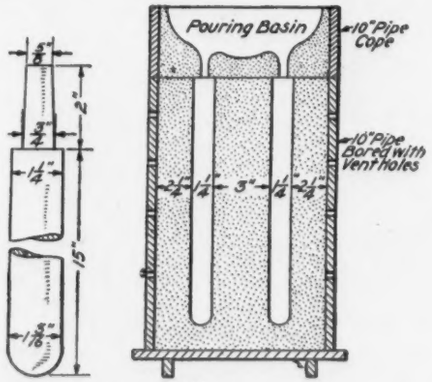


FIG. 1

remain at this temperature during the time the casting is immersed.

(c) Each casting shall be heated to a uniform temperature of about 300 degrees Fahr. immediately before it is dipped, and shall possess this temperature at the time it is put in the bath.

(d) Each casting shall remain in the bath at least two minutes.

(e) Fresh pitch and oil shall be added when necessary to keep the mixture of the proper consistency, and the vat shall be emptied of its contents and refilled with fresh pitch whenever the accumulation of sand or carbonaceous matter renders this desirable, as can be seen by the solids adhering to the under side or lower ends of the castings.

(f) After being coated, the pipe and fittings shall be carefully drained of the surplus varnish.

II.—Chemical Properties and Tests

3. Drillings taken from the fractured end of the arbitration test bar shall not contain over 0.10 per cent of sulphur.

*Adopted as standard by the American Society for Testing Materials, 1918.

(*Continued on Data Sheet No.* 348)

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

SPECIFICATIONS FOR CAST-IRON SOIL PIPE AND FITTINGS

(*Continued from Data Sheet No.* 347)

III.—Physical Properties and Tests

4 The transverse test specimens (arbitration test bars) specified in section 7, when placed horizontally upon supports 12 inches apart and tested under a centrally applied load, shall conform to the following minimum requirements:

AVERAGE LOAD AT CENTER, LB.	2500
AVERAGE DEFLECTION AT CENTER, IN.	0.10

5. All pipe shall be tested to a hydrostatic pressure of not less than 50 pounds per square inch before coating. Any casting showing defects under this hydrostatic test shall be promptly broken and returned to the cupola.

6. The form and dimensions of the mold for the arbitration test bar shall be in accordance with Fig. 1. The bottom of the bar shall be 1/16-inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask shall be rammed up with green molding sand, a little damper than usual, well mixed and put through a No. 8 sieve, with a mixture of 1 to 12 bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried, and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled. It shall not be rumbled or otherwise treated, being simply brushed off before testing.

7. From each melt of metal not less than three test specimens (arbitration test bars) shall be poured, the first of which shall be poured within five minutes after the first ladle is tapped and the remainder at intervals not exceeding one hour throughout the melt.

IV.—Standard Sizes and Weights

8. (a) The inside diameter of the barrel of any pipe or fittings or branch thereof shall not vary more than ⅛-inch under the nominal size of pipe.

(b) The outside diameter of the barrel of pipe and fittings shall be ¼-inch greater than its nominal inside diameter A variation in the outside diameter of ⅛-inch over or under these figures will be permitted.

Table I

WEIGHT OF SOIL PIPE

Size, in.	Single Hub Per 5-ft. Length, pound	Per ft. including Hub, pound	Double Hub Per 5-ft. Length, pound
2	27½	5½	27½
3	47½	9½	47½
4	65	13	65
5	85	17	85
6	100	20	100

(*Continued on Data Sheet No.* 349)

THE FOUNDRY DATA SHEET, SEPTEMBER 1, 1920
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Bill Solves An Old Problem

BY PAT DWYER

BILL and I stood on a downtown corner the other day watching a parade. In those far away days, which now seem like a dream, Bill played a fife and I rattled a snare drum in an amateur fife and drum corps and when that organization broke up, as such things nearly always do, we offered our services to the town cornet band. After a few trials with an alto horn and a few visits to the dentist I decided that I would never make any reputation with that instrument; but Bill had a magnificent set of teeth and quickly developed a *lip* which influenced the band master to assign him the E-flat, solo cornet parts. To hear him do the cadenza in "Afton Water" was a treat, and when he triple tongued the E-flat parts in "The High School Cadets", "King Cotton", "The Stars and Stripes Forever", and other stirring compositions of the well known John Philip—a man who didn't feel like yelling *encore* must have been deaf or have had a soul like a cow.

The memories of a man's first love will remain with him all the days of his life, whether these memories center around a plug of tobacco or an angelic creature who wore a faintly scented, lilac sprinkled muslin dress and shyly said *yes* when he asked her blushingly if he might see her home from the first party. Therefore, it is only natural that when Bill and I see a parade, our interest centers in the bands.

On this occasion we sized them up critically and technically, but when a fife and drum corps passed, Bill insisted on quitting a perfectly good vantage point which we had secured and boring his way through a crowd for a distance of several blocks until the boys had finished a selection they were playing. "You can talk about your bands and orchestras," said he, "but for pure, exquisite pleasure; something that keeps your heart in your throat, and your feet stepping out on the sidewalk in time to the music, give me a memorial day parade with two old veterans, service caps cocked askew, playing fifes, and a third, alert and white haired, with his cap at even a more rakish angle, tapping a snare drum like an artist. Listen to "Yankee Doodle", "Marching Through Georgia," and the rattling, lilting crescendo measures of "Dixie" and it is easy to understand how men fought, bled and died during the red days from '61 to '65."

"What's the idea"? I said. "To hear you talk one would imagine you were a candidate for something, or else a professional spellbinder with an eye on the old soldier's vote."

"'Pon my word," said Bill. "Whenever I cast pearls before you I am almost forced to the conclusion that there is something in the theory of transmigration of souls. If there is I am quite positive that in a former incarnation you were equipped with a much longer snout and a curly tail."

He rapidly executed a strategic movement to the rear which brought his back up against a jeweler's plate glass window and dared me to throw any paving blocks at him.

I abandoned the idea of beaning him; not, I assured him because he deserved any mercy but because if I did so, some narrow minded people might think I was trying to divert attention from the parade. However, I assured him, that it would afford me great pleasure to go out to his foundry some day and *get him* through one of the broken windows.

"At this season of the year," I said, "most of the glass is bound to be broken and I can rake you fore and aft. If that does not finish you, I'll bribe one of your cupola men to spill a wheelbarrow of pig iron on you as you pass under the stage."

"What you said about the windows is correct in the main," said Bill, "but I know of many foundries right now which have their full complement of windows but the glass in them is so covered with dirt and grime that they might just as well not be there for all the good they are. They serve one purpose admirably. They prevent the men inside from looking out and thus losing interest in their work, and they prevent vulgar people from gawking in at the workmen and thus embarrassing these sensitive, refined and high-strung artists.

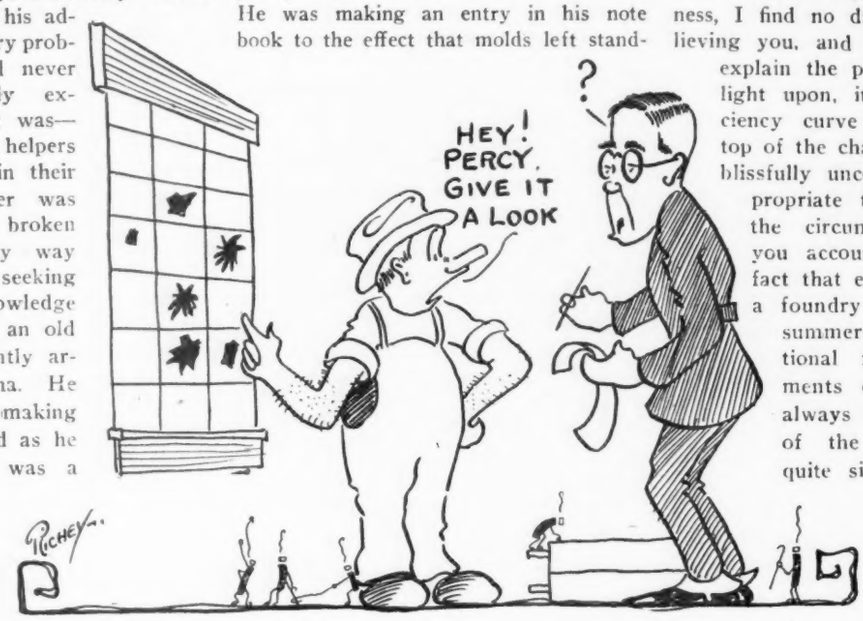
"It is funny how climatic conditions affect the window glass in a foundry. You never see a broken window in the winter. Hail, sleet, snow or rain, it is all the same, the good old panes defy them all; but with the first balmy breath of spring they commence breaking at an alarming rate until by mid-summer there is not a whole sash in the place.

"I often have attempted to figure out this phenomenon and almost had reached the conclusion that a certain amount of intentional carelessness on the men's part was responsible when the question was settled for me by a bright young lad who was learning to be a general manager by spending a month in each department of the plant. When he reached the foundry he told me that he did not wish to be assigned to any particular job. He said he was only allowing himself a month in which to make an intensive study of foundry routine and operation. Therefore he would take it kindly if I did not interfere with him but just let him make his own investigations and draw his own inferences. I assured him, truthfully I hope, that nothing would give me greater pleasure; but I also said, which was not strictly a truthful statement, that I would appre-

THE BOYS OF THE OLD BRIGADE ARE THE CENTER OF INTEREST AT EVERY DEMONSTRATION

ciate any tips or advice he might feel inclined to give me from time to time. He gracefully admitted that he would be pleased to do so; but in view of the fact that his time was limited he intimated that I should make the questions as brief as possible, or, as he put it 'make 'em snappy.'

"I turned the proposition over in my mind for several days and finally decided that I would seek his advice on two foundry problems which I had never heard satisfactorily explained. The first was—Why do colored helpers always cut holes in their shoes? The other was the problem of the broken windows. On my way through the shop seeking the fountain of knowledge I was stopped by an old 'bo who had recently arrived from Alabama. He was engaged in making a 6-foot pulley and as he understood there was a big difference between Northern and Southern foundry iron he wanted me to advise him whether it was necessary to place a feeding riser on the hub. I told him to do so by all means and to be sure to feed it up well after it was cast. Having settled that point, it struck me that since he was probably familiar with conditions in the South he could explain the shoe enigma.



THE BROKEN WINDOW MYSTERY IS EXPLAINED IN A SCIENTIFIC MANNER

"He laughed when I asked him and said that he had nothing to prove it; but down where he came from it was the generally accepted belief that gentlemen of color *breathed* through their feet. He said that he had worked in a big plant down there where the management had instituted safety methods and among others had insisted on the foundry employes wearing congress shoes. They even went so far as to supply every man with a new pair, free, to encourage their adoption. The first day they had them on every colored helper in the place had cut a row of port holes on both sides along the water line. The old boy assured me that if he was running a foundry in the South he would shoe all the helpers like mules.

"With this weight off my mind I continued down the shop until I located the young man of whom I was in search. He was making an entry in his note book to the effect that molds left standing over night invariably produced bad castings on account of the facing sand getting sour. He stuck the note book in his pocket, pulled up one sleeve to note the time and then assumed, to the best of his ability, the facial expression and manner of speech ascribed to successful captains of industry by our leading novelists—you know, brows drawn down to indicate the most intense concentration, eyes darting out shrewd glances through half closed lids; etc. He addressed me in one of those short, crisp sentences which according to the same authorities is characteristic of the modern American financial giant.

"'Well, Bill,' just like that.

"I told him that I wanted his advice on a certain foundry problem; but before taking it up I asked him why he had looked at his watch when I had approached him.

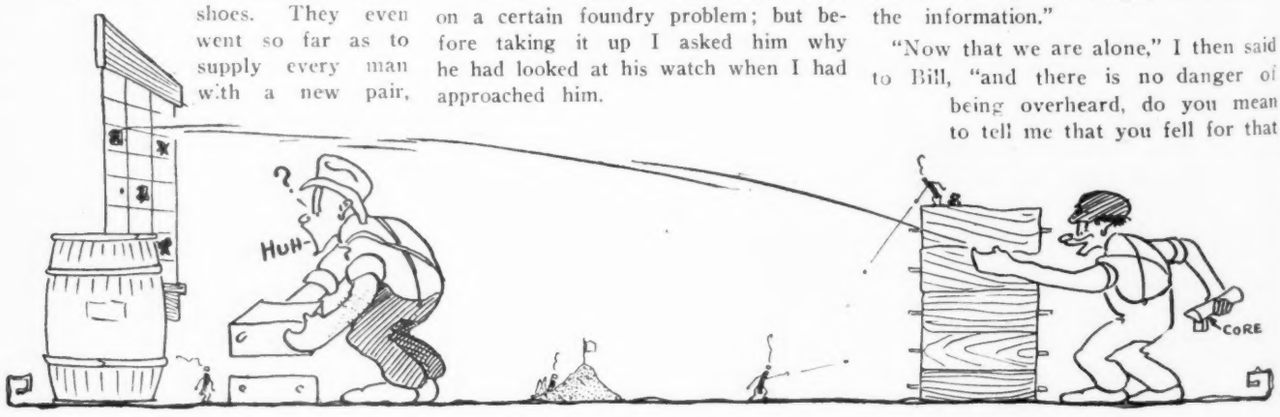
"'Part of my system,' said he. 'I time each one of my actions all day, then by plotting them on a chart at night and comparing the actual curve with a theoretical curve I can measure my efficiency. I really think that the time I devote to this part of my work each night is the most important thing I do all day.'

"'Fine business,' I said. 'Fine business, I find no difficulty at all in believing you, and I think if you can explain the problem I want some light upon, it will run your efficiency curve pretty well to the top of the chart.' 'Shoot,' said he, blissfully unconscious of how appropriate the term was under the circumstances. 'How do you account,' I said, 'for the fact that every window pane in a foundry gets broken in the summer time and the additional fact that the fragments of broken glass are always found on the outside of the building?' 'That's quite simple,' said he. 'The foreign material covering the glass has a different coefficient of expansion from the glass itself the heat from the sun's rays acting directly on the outside surface of the glass expands that side until it exceeds the elastic limit and then there is nothing left for it but to break. The curve on the outside throws the center of gravity beyond an imaginary perpendicular or vertical line on the face of the sash and consequently the glass falls on the outside of the building.'

"He flipped out the note book, consulted the dinky little time piece, made an entry under the heading *Expert Advice* and said 'Anything else?'

"I said no, I did not think there was anything else worthy of his attention; but I certainly felt obliged to him for the information."

"Now that we are alone," I then said to Bill, "and there is no danger of being overheard, do you mean to tell me that you fell for that



ANOTHER EXPLANATION OF THE BROKEN WINDOW MYSTERY—NOT GUARANTEED BUT OFFERED FOR WHAT IT IS WORTH

line of bunk?" "That's the kind of question that no one never answers," said he. "You might just as well expect the apprentice boys to admit that they broke the windows after finding short, hard pieces of round stock cores among the debris. You can form your own opinion but you can't prove anything."

Chilled Edges Are Cause of Trouble

By H. E. Diller

Question.—We are having considerable trouble machining our gray iron cylinder castings on account of hard iron. Our chemist advises us that the iron contains: Silicon, 2.30 per cent; sulphur, 0.075 per cent; phosphorus, 0.650 per cent, and manganese, 0.70 per cent. He also says that it is not possible to further soften the iron and produce solid cylinder castings.

Answer.—We know of one foundry that is making cylinder castings from metal of practically the same composition as the iron you are using, and obtaining sound castings easily machinable. We think that possibly your trouble is from getting the edges of your castings chilled by having too sharp corners or the sand too damp. We have known foundries that have had this trouble caused by swabbing the corners of their molds with too much water. While their iron in the main body of the castings was soft and readily machinable, some of the corners of a few of the castings would be chilled and dull cutting tools.

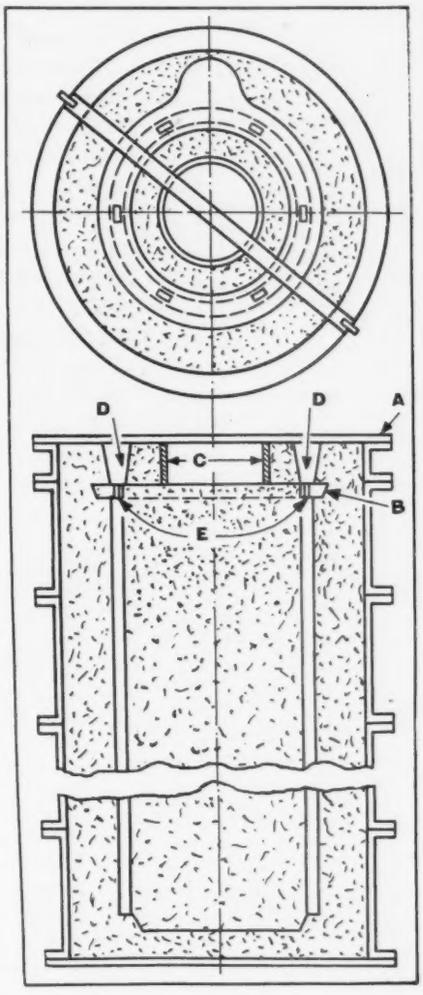
In general cylinder foundries use an iron with lower phosphorus content in order to insure castings free from porous spots. Many foundries carry the phosphorus in the vicinity of 0.200 per cent. We would recommend that you use a flux consisting of 25 pounds limestone and 2 pounds fluor spar per ton of metal. This should be placed on each charge after the second, toward the center of the cupola so as not to wash against the side walls.

Vertically Cast Hollow Rolls Are Warped

By Pat Dwyer

Question: I have been having trouble lately on account of rolls warping and would appreciate any information you can give me on the subject. The rolls are poured with gray iron in dry-sand molds. I made a dozen or more of these castings which were straight and satisfactory but the last three I have made are quite crooked. They are all the way from an inch to half an inch out in the center. The roll is 7 feet 6 inches long by 13 inches outside diameter. A straight core 9½ inches in diameter extends from end to end.

Answer: Without further details it is impossible to say definitely what causes the castings to warp. It might be caused by a warped pattern; a crooked core or by having an unequal thickness of sand around the casting.



THE ASSEMBLED MOLD READY FOR POURING—*A* INDICATES THE STRAP FOR HOLDING DOWN THE MAIN CORE; *B* IS THE RING COVERING CORE; *C* IS THE IRON BUSHING; *D* IS THE POURING BASIN, AND *E* SHOWS TWO OF THE GATE OPENINGS

Probably your trouble is due to the latter cause. If you are molding the roll on end in a round flask it is probable that the pattern is kept close to one side to allow room for the upright runner. If that is the case the roll invariably will warp because the heat from the thin side of the mold will radiate much faster than from the side carrying the runner. The thin side will contract first pulling the ends of the casting toward each other and springing the back. The other side will contract later, but cannot do so normally on account of the resistance offered by the side which already has set and become rigid. A familiar example of this phenomenon is seen in casting open-sand plates. If they are left to cool naturally after they are poured the ends will spring up. The common remedy for this is to shovel sand on the ends and leave the center uncovered, thus equalizing the cooling process.

The regular roll shops overcome this tendency to warp by providing extension pockets on the flask sections to carry the upright runner and thus are enabled to keep the roll in the center of the flask with an equal thickness of sand all around it.

Where rolls are only made occasionally and it is desired to run them from the bottom, square flasks are the best because the runner can then be kept in one corner.

In your case try round flasks; but instead of pouring the job from the bottom, pour it through six ¾ x ½-inch pop gates evenly spaced around the top. To insure a perfectly clean casting it might be advisable to dispense with ramming a cope. Instead a loose ring 1½ inches thick could be sawed out on the band saw and slipped over the top of the pattern. A round flat corebox corresponding to the shape and size of the ring and containing small upright pieces to form the gate openings could be used for making a cover core.

After the mold is dried and the upright core set the ring core dropped into place will center the upright core automatically. A wooden block to form the basin then is placed over the gate openings followed by a shallow flask ring which serves to hold the green sand which is rammed around the basin block. An iron bushing or other suitable packing on top of the upright core can be secured by a flat strap clamped across the top flange. The general arrangement is shown in the accompanying illustration.

Where cylindrical cored castings are molded horizontally in a split flask and afterwards upended for pouring, it sometimes happens that the mold is sprung in the center due to insufficient support under the center of the roll-over board while ramming the drag or the same condition prevailing after the mold has been rolled over. This will result in a thick and a thin side on the mold after the core is placed. When the casting is poured the thin side contracts first and the casting will be crooked irrespective of whether it is in the center of the flask.

A new blast furnace, with a capacity of 100 tons of sand-cast pig iron daily, has been put in blast at Hankow, China, according to reports to the department of commerce.

C. P. 1 A 12-19

TIME STUDY

DATE _____ DEPT. NO. _____ EQUIP NO. _____

TYPE OF EQUIPMENT _____

SPECIAL FIXTURES _____

PART NAME _____

KIND OF MATERIAL _____

OPERATION _____

NO. OF EMPLOYES _____

FORMER STD. TIME HRS _____ FORMER PRICE $ _____ REFER TO REGISTER NO. _____

REASON FOR CHANGE _____

STANDARD PROD. PER HR. _____ STANDARD TIME HRS _____ RATE FOR PRICE $ _____ PIECE PRICE $ _____

STANDARD COST $ _____ BASED ON AVE. HOURLY RATE $ _____

REMARKS: _____

PART NO. _____ OPER NO. _____ REGISTER NO. _____

TAKEN BY _____ ON EMPLOYE NUMBER _____ CHECKED BY _____

APPROVED _____ APPROVED _____

(SEE DETAIL ON REVERSE SIDE)

DETAIL OF TIME STUDY

ITEM NO.	OPERATION	TIME TAKEN MINS.		ALLOWED MIN.	
1	Place Flask	28			
2	Dust-Place Board	17			
3	Place Riddle & Facing	09			
4	Shovel & Riddle Sand	15			
5	Shovel & Ram Sand	34			
6	Place Bottom Board	05			
7	Turn Flask Over	08			
8	Dust-Place Board	18			
9	Place Riddle & Facing	08			
10	Shovel & Riddle Sand	16			
11	Shovel & Ram Sand	44			
12	Cut & Form Sprue	05			
13	Lift Cope	13			
14	Draw Pattern	12			
15	Set Strainer	13			
16	Replace Cope	14			
17	Remove Flask	10			
18	Place on Floor	18			
		3 06	3 14		
	TOTAL ITEMS			3	10
	ALLOWANCES Contingencies 38.5%			1	19
	NO. PIECES 6	TOTAL TIME—MINUTES		4	29
	AVE. TIME PER PIECE .715	STD. HOURS .812			

2 pcs. per hr. 101.4 pcs. per hr.

FIG. 1—THE TIME-STUDY CARD IS LOOSE-LEAF—THE FRONT OF THE CARD IS USED FOR GENERAL INFORMATION ABOUT THE JOB SUCH AS DESCRIPTION OF THE EQUIPMENT FIG. 2—DETAILS OF THE TIME REQUIRED FOR EACH ELEMENTARY DIVISION OF THE OPERATION ARE RECORDED ON THE BACK OF THE TIME-STUDY CARD

C. P. 27 1-20

TIME STUDY REGISTER

FROM NO. B58 TO NO. B76

DATE 1920	REGISTER NO.	PART NUMBER	OPERATION	STD. TIME HOURS	PIECE PRICE	TIME STUDY TAKEN BY
1-19	B-58	SD35	Mold-Set Cores-Pour Shake Out	.06		C. L. Lyman
1-19	B-59	SD33	" " " " " "	.06		"
1-19	B-60	SD32	" " " " " "	.06		"
1-20	B-61	1382-11	" " " " " "	.045		"
1-21	B62	36699	" " " " " "	.021		"
1-22	B63	37832	Mold-Pour-Shake Out	.036		"
1-29	B64	47482	" " " "	.0143		"
1-29	B65	48273	" " " "	.018		"

FIG. 3—AFTER THE TIME STUDY IS MADE A RECORD OF IT IS KEPT ON THE TIME-STUDY REGISTER—THE TIME-STUDY CARD CAN THEN BE LOCATED BY THE REGISTER NUMBER WHICH IS GIVEN IT

Time Study Underlies Bonus System

Production Department Determines Standard Time for Different Foundry Operations and Keeps a Record of the Amount of Each Kind of Stock on Hand and Being Consumed

BY H. E. DILLER

IN SOME few shops the proprietor of the foundry is also the manager, the whole molding and core-making force, besides being cupola tender and shipping clerk. Such an industrial organization has some advantage over the big company with its hundreds of employes, in that it has no need for scheduled system. However, as soon as a foundry employs more than one man, some form of production system is introduced. When the number of employes reaches the hundreds or possibly to the thousands, the difficulty of successfully directing the activities of all these workmen in their various activities is more and more complicated. In recent years the production department has become more important in the foundry. The comparatively new department has had many difficulties to overcome and much prejudice to meet in establishing its sphere in the foundry, but it has proved its essential value and now every large foundry has a force of men operating under the name of production department or performing the functions of such a division.

Production methods at the Saginaw Malleable Iron Co., largely are under direction of the production department of the General Motors Co. which has a staff of trained experts which applies the basic principles of production to machine shop, assembling department or foundry with equal facility. At times slight modifications in the standard forms will fit them for work in a particular department. In such cases the modifications is made but the essentials are kept as close as possible to the original standard form.

The work of the production department is split into two general divisions; the one handling materials and production control, and the other the standards or time-study department. This latter section determines the time which is necessary to make each new job which comes to the foundry. This is done by a time study in which the length of time for each operation is found and established. Time studies also are taken when any change is made on a pattern involving even a slight modification of the operation. The time studies serve as a basis for determining the bonus to be added to the hourly rate at which the workmen are paid. This hourly rate is determined by the rate being paid in the trade for day labor.

The molder is paid his hourly rate no matter how many molds he makes, but if he makes more than 75 per cent of the molds which the time-study department has determined is the standard rate for the particular pattern, he will receive a bonus. The amount of the bonus varies with each per cent of the established base up to 200 per cent. At 76 per cent the lowest bonus, which amounts to 1.6 per cent is paid. When the molder makes what has been determined should be a normal day's output, or 10 per cent standard time, he receives a bonus of 20 per cent. This amount is increased to 50 per cent when 125 per cent efficiency has been reached; while at 150 per cent efficiency, above which few molders go, an 80 per cent bonus is paid.

In setting the standard time, it is considered that a good workman will average 110 per cent or better, which brings him a bonus of 32 per cent. Therefore, the inducement is considered liberal enough to induce the workmen to strive

Time Study Principles

ABSOLUTE fairness on the part of both management and employe is essential for the success of any bonus system. The basis upon which the bonus

is paid must be established with the most exacting care, and when once established, the company will expect that the compromise and the time allotstand by its efficiency is not cut down principles of ed as greater time study are elucidated in the following excerpt obtained. The taken from a circular written by E. K. Wennerlund, General Motors Co., for the direction of the production departments of the various branches of that company, including the Saginaw Malleable Iron Co. Mr. Wennerlund says:

The primary object in taking a time study of a shop operation is to arrive at a *standard time*, i. e. standard rate of production. This standard of production, when established, may be used as a basis for either of the following:

Payment of a bonus as a reward for efficient production.
Establishing a piece rate for the operation.
A check on present or proposed shop methods.

Standard time may be defined as the time required to perform a given operation, or a group of operations, by the average competent workman, repeatedly over an extended period. Lost and waste time is eliminatd from the standard time, except to the extent of providing for minor delays incident to the shop conditions.

The purposes aimed at in placing standard time on operations in the shop, and offering a bonus reward for production, are as follows:

To stimulate the workman to greater effort.
To reward him in proportion to that effort.
To furnish a standard for the measurement of the rate of production.
To measure the efficiency of the workmen, individually or in groups.

A time study should be taken by a specially trained investigator. He should have the full co-operation and support of the department foreman, while in the exercise of his duties. When preparing to take a time study, the investigator should ascertain that the equipment is in a first-class condition; that light and ventilation are satisfactory; also, that the material to be worked on is in good standard condition for the operation.

He will also investigate and record, as a result of motion study, the number and kind of motions necessary to perform the operation in the easiest manner and the shortest time. He should inform the workman fully what are the purposes of the investigation, and get him to conform his methods to the best shop practice.

for as large a bonus as possible. Of course, it is essential that an hourly base rate be established which is consistent with prevailing wages in the community. The Saginaw company has decided that there is nothing to be gained by maintaining a low hourly rate and then raising the standard time to make the total earnings attractive. It has been found that high hourly rates attract good producers. The management insists on a workman doing a fair day's work to remain in service.

Naturally, when the wages paid the molder depend on the time study it is necessary to use every precaution to see that a fair rate is set. The man who does this must be familiar with the work as well as with human nature. He must know how to divide the job into different operations and be able to determine whether the molder is trying to perform the operation normally. Such ability is only acquired by long practice. Therefore, only one man is employed to set the standard time rate.

When a time study is made, the results are put on the back of a time-study card as illustrated in Fig. 2. The figures in this illustration, as in all other illustrations in this article, are not given as actual but are assumed figures which are assigned merely to elucidate the working of the system. A division of the job is made into its different elementary operations, and the time for each operation is recorded in hundredths of a minute by use of a decimal stop watch. A second observation is made to compare with the record of the first. Should the time consumed by any elementary observation vary in the two trials, a third or even a fourth trial is made and the reason for the variation is determined. At times it is impossible to induce the molder to enter fairly into the spirit of the study. In such cases the investigator must be able to tell when false results are being obtained through lack of co-operation of the molder, and if the molder cannot be induced to give the time study a fair trial the investigator sets a time which he judges as fair. This occasion seldom arises, as the molders appreciate the system after they come to understand it and realizes its fairness. In case the second observation tallies closely in the time of all elementary operations, the individual results are not put on the card, but the total time is recorded. The time for the two trials is then averaged to secure the time to be allowed for the operation. In setting the allowed time the investigator must take into consideration an average good working condition for each operation.

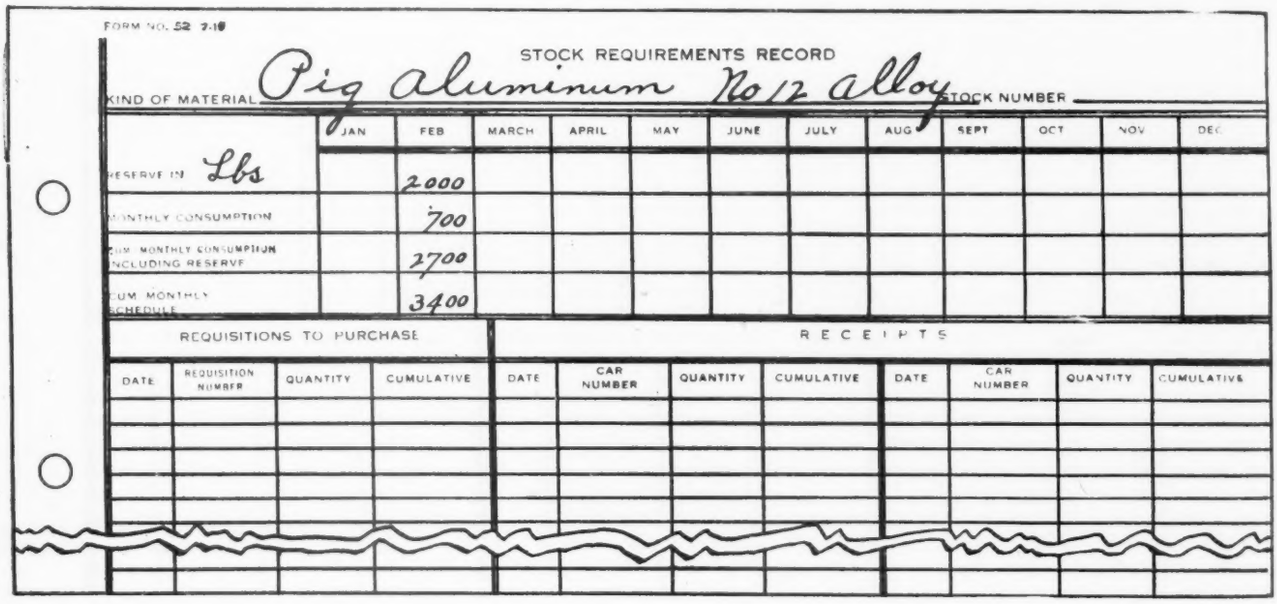
The elementary divisions on the time-study form show only the net time without any allowance for contingencies. The total of these items then shows the net time for the complete operation. It is thought essential to adhere to this practice so that the time study may be of value for future reference. However, certain allowances incident to the operation are made to have the established time represent the standard rate of production repeatedly over an extended period and to allow for unavoidable contingencies. Ten per cent is the average time allowed for contingencies. In addition to this, an extra allowance of 28½ per cent is allowed for pouring. The molder works nine hours a day and it is estimated that two hours of this time is consumed in pouring the molds and shaking out castings. A secondary allowance sometimes is considered to take care of extraordinary conditions not incidental to the operation.

The sums of all items are averaged and placed in the line marked *Total Items*, Fig. 2. Below this figure is the time allowed for contingencies. These two are added together to make the total time in minutes, which is carried out to the hundredth of a minute. The number of pieces in a flask, the average time per piece, and the standard hours also are marked at the foot of the page, as illustrated in Fig. 2. The average time in minutes is obtained by dividing the total time by the number of pieces in a mold. The standard number of hours is secured by dividing the average time per piece by 60, which converts the average time into decimals of an hour.

When this work is finished, the management has, on the back of the time card, a record which can be referred to at any time. On the front of the card is kept a detailed account of the job. As shown in Fig. 1, this includes the date the time study was made, the type of equipment, a complete description of the equipment, a list of special fixtures, the kind of operation, the number of employes working on the job, standard production per hour, etc.

All time studies are numbered serially and registered on a form known as the *Time Study Register*, Fig. 3. This register number then appears on all job tickets or credits where the standard time is used. Any change in standard time requires that a new time-study form be made, with a new register number, stating reasons for the change.

These register numbers may be prefixed by a letter, in which case the numbers run serially after each prefix.



FORM NO. 52 7-18

STOCK REQUIREMENTS RECORD

KIND OF MATERIAL Pig aluminum No 12 alloy STOCK NUMBER

	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
RESERVE IN Lbs		2000										
MONTHLY CONSUMPTION		700										
CUM. MONTHLY CONSUMPTION INCLUDING RESERVE		2700										
CUM. MONTHLY SCHEDULE		3400										

REQUISITIONS TO PURCHASE				RECEIPTS							
DATE	REQUISITION NUMBER	QUANTITY	CUMULATIVE	DATE	CAR NUMBER	QUANTITY	CUMULATIVE	DATE	CAR NUMBER	QUANTITY	CUMULATIVE

FIG. 4—CLOSE ACCOUNT OF THE STOCK ON HAND AS WELL AS THE AMOUNT BEING CONSUMED IS KEPT ON LOOSE-LEAF FORMS

C P 4 D 1-20

GROUP ROUTING

PART NAME Steering Gear Bracket MODELS Northway PART NO S.M664

DATE Mar. 1, 1920 THIS ISSUE NO 5 NO. OF SHEETS 1 SHEET NO. 1 BOOK NO 6

DEPT.	DIVN.	GROUP	RATE	OPERATION	DETAIL EQUIP. NO.	DETAIL REG. NO.	DETAIL TIME	REGISTER NUMBER	S. T. HOURS	PRICE $	PRODUCTION PER HOUR
EQUIPMENT				METAL PATTERN— 1 GATE— Plate							
				Snap FLASK 18X11X8							
				BOTTOM BOARDS 18X11							
				2 BANDS—JACKET 0							
				CHILLS 0							
				# 1 CORE— 2 Gang BOX— Oil SAND— 1 REQ'D							
				# 2 CORE— 4 Gang BOX— Oil SAND— 1 REQ'D							
				# 3 CORE— BOX— SAND— REQ'D							
2				MAKE # 1 CORE C. P. 28 LOTS	CB			C15	0277		36
2				MAKE # 2 CORE C. P. 28 LOTS	CB			G31	0248		206
2				MAKE # 3 CORE C. P. 28 LOTS	CB						
2A				BAKE—INSPECT—CORES TO STORAGE	CA CJ						
3				MOLD—SET CORES—POUR—SHAKE OUT	X			R121	122		10
5				SHIFT MOLD				F.96		.01	
5				DUMP MOLD							
5		5-1		TRIM AND TRUCK							
6		6-1		HARD IRON TUMBLE—TO INSPECTION ROOM	HA						
7A		7-2		CHIP—INSPECT—SORT—WEIGH	SB—SS			G62	.03 per piece		
7		7-1		GRIND—TO ANNEALING ROOM	SA			G48	$.25 per hour		
8		8-1		PACK POTS—LOAD OVEN FOR ANNEALING—	AC AH			G81	$.07 per load		
				UNLOAD AFTER ANNEALING—DUMP POTS—	AT AB						
				TO SOFT IRON MILLS							
8				ANNEAL	AA						
9		9-1		SOFT IRON TUMBLE—TO SORTING ROOM	TA						
10		10-1		SORT—INSPECT	PA						
10				SHIP							
				NOTE 1							
				NOTE 2							

ISSUED TO BOOK NOS 1 TO 6 INCLUSIVE KIND OF MATERIAL

FIG. 5—THE STANDARD TIME ALLOWED FOR THE DIFFERENT OPERATIONS IS NOTED ON THE GROUP ROUTING SHEET—A COLUMN ON THIS SHEET IS ALSO RESERVED FOR RECORDING THE VARIOUS REGISTER NUMBERS FOR THE SEVERAL OPERATIONS

For example, under the group bonus plan a number of minor operations are combined into one group operation, and the standard time for the latter is the total time in man-hours of its minor operations. In this case it will be found convenient to designate minor operation time study numbers with the prefix *D*, and group operations by prefix *G*.

For group operation standard times, a separate time study from Figs. 1 and 2 is filled out showing register number, name of operation, and standard time of each minor operation. If an extra allowance of time is necessary it should be included, not for the minor operation but for the group operation; thus, showing basic standard time only, for the minor operations. This facilitates the rearrangement of minor operations from one group to another on the routing sheet, without referring to the time study for each operation.

Before the standard time becomes official, the manuscript is audited carefully in the standard department office. All additions are checked and reference is made to time studies covering similar operations, so that no mistake is made. The standard time system with a bonus reward, is considered to be essentially a day-work plan as distinguished from the piece-rate system. Each employe receives a fixed hourly rate, and an additional bonus is paid, dependent on the speed of production. By dividing the cumulative standard hours, for a period, by the corresponding actual elapsed hours, the relative efficiency of production is obtained. The per cent bonus to be paid in addition to the base wage for the elapsed hours is obtained from a bonus table, which has been standardized. When computing the efficiency of groups of employes, man hours, both standard and actual, always are used. At or below an efficiency of 75 per cent, the employe is automatically on a flat day rate, zero bonus being earned.

To make the standard time effective as a wage plan, it is deemed requisite that production be speeded up to where the employe can earn a substantial bonus, amounting to 20 per cent or better, in addition to the base wage. It is the duty of the standards department through its shop investigators, to see to it that a satisfactory degree of efficiency is maintained on each operation. Where the efficiency shows low, the first step is to determine the reason. Any one of the following conditions may exist:

The standard time may be too low for the average conditions.
The operator may be incompetent. He may lack interest.
A temporary poor quality of material, or a bad condition of equipments, ventiation, or room temperature may obtain.

If the standard time is found to be too low, it is remedied by taking a new time study. Where the other conditions exist, the full co-operation of the department foreman and the factory management is secured. The standards department is required to watch the case until the adverse conditions have been rectified. Generally speaking, it has been found that if the standard time is fair, and surrounding conditions near normal, the workman will do his utmost to maintain a high degree of efficiency, he is convinced that the expected rate of production is attainable.

Since it should be the policy to allow a basic standard time to stand permanently when once established, unless

there is a change in equipment, materials, or methods, care is exercised that standard time is not set until it is correct. Unless the workman can feel confident that the time will not be changed under existing conditions, he is not likely to put forth his best efforts. When new methods or equipment are introduced, a new time study based on the changed conditions is justified. Where the workman makes a suggestion resulting in improved methods or equipment, he is suitably rewarded by the management; for it is estimated that to allow the standard time to stand under the improved conditions will cost a great deal more cumulatively than would a liberal cash reward paid when adopting the suggestion for saving time.

The bonus is computed for each pay period. It is pointed out to the workman that if he attains a high efficiency for part of a pay period, and a lower efficiency down to 75 per cent, for a portion of the period, that he does not lose the bonus which has been earned previously. It may lower his average efficiency, and hence the percentage of bonus, but this percentage is computed over a longer period; so that bonus once earned within these limits, is not subsequently lost.

Application of the standard time system is shown in the form illustrated in Fig. 5. This is the group routing for a steering gear bracket. It gives a description of the equipment required, the number and kind of cores, and a list of the different operations such as, make core, mold set cores, pour shakeout, shift mold, dump mold, chip, inspect, sort, weigh, etc. Then in two columns toward the right the register numbers are given and the standard time hours for the different operations are noted. The estimated production per hour is indicated in the last column.

Another function of the production department is to keep the management and the purchasing department informed as to the state of stock on hand. The management decides how long ahead the foundry should be covered for the different materials and the purchasing department makes the contracts. However, they secure their data from which they derive the amount to be contracted from the production department who must keep continually informed on the state of the reserve of all materials. In case the amount of any material on hand is above or below the amount decided on as the proper reserve the purchasing department must be notified. To have this information constantly available a record is kept on the form shown in Fig. 4, headed *Stock Requirement Record*. The name of the material and the stock number are placed on the first line. The table immediately under this is so arranged that a year's record may be kept of the reserve in pounds, tons, gallons or whatever it may be; of the monthly consumption; of the cumulative monthly consumption including reserve obtained by adding the two; and of the cumulative monthly schedule. Below this are two tables for keeping a record of the requisitions and the receipts. Other forms are necessary for reporting the daily consumption and summing up the monthly total consumption, but this form tells the story at a glance of how much stock is on hand and how much is due on orders together with the consumption.

Melting Steel and Iron in the Cupola

Question:—We have considerable cast scrap with machine steel fast to it. Would it be any disadvantage to our melt to put say 10 per cent of this steel and iron in the cupola? We make machinery castings and use 2/3 scrap and 1/3 pig iron.

Answer:—Instead of being a disadvantage the addition of steel to the cupola charge in amounts varying from 5 to 40 per cent now is recognized as a distinct advantage. It does not matter whether it is added in the shape you mention or whether it is added as a separate and distinct part of the charge, as boiler punchings, clippings or any other form of steel scrap.

The only point you have to watch is the silicon content. The amount of silicon in soft steel scrap is practically negligible, and cast iron loses approximately 0.25 per cent when melted. Therefore when making up the charge, it will be necessary to allow for the absence of silicon in the steel and the cupola loss in the iron.

At present you are using 33 1/3 pig iron and 66 2/3 scrap which probably gives you iron about as hard as you care to machine in thin sections. The substitution of part of the scrap charge with steel would make this still harder and therefore it will be necessary for you either to use a little more pig iron, to use the same relative proportions of pig iron but of a little higher silicon content, or to use the same relative proportions of pig iron and scrap as at present and in addition about 10 pounds of 50 per cent ferrosilicon to each ton of iron.

Defective castings, those having blow holes and hard spots, are frequently attributed by amateurs to steel in the charge when in reality they are due either to poor molding or furnace practice. To secure clean, solid castings, the iron must be melted hot and this is particularly true when the charge is partly made up of steel. By *hot* is not merely meant hot enough to run but what the foundryman calls *smoking hot*.

Manganese Hardens Welds

Successful results obtained from a considerable number of welds made by several large steel mills have shown, according to a statement by the Metal & Thermit Corp., New York City, that the life of wobblers on pinions, rolls and large shafts which have been repaired by thermit welding, after previously having been worn away or broken, can be materially prolonged by the addition of 3 per cent pure manganese to the railroad thermit, in addition to the 1 per cent of pure manganese already in the product. This will give a hard wearing surface. Wobblers should be thoroughly heated to about 1400 degrees Fahr. before welding; otherwise no amalgamation of the two metals will be obtained.

Build Mexican Plants

Arrangements have been made by the Oil Well Supply Co., Pittsburgh, and the Tampico Foundry, Machine & Supply Co., to build plants upon La Isleta, an island which has a large frontage on the Tuxpam river, near Tampico, Mexico. These corporations have purchased land upon the island on which they will locate their plants. The Oil Well Supply Co. will expend about $400,000 in the construction of machine shops, warehouses, etc., while the Tampico Foundry, Machine & Supply Co., besides moving its foundry and machine shops to the new location will expend about $100,000 in new equipment.

Claims Process to Make Steel from Ore

According to a report from Brussels, the Belgian ironworks of the Ougree-Marihaye have recently acquired, from a French engineer, for the sum of 1,000,000 francs the patent for all countries for producing steel direct from iron ore, the blast-furnace coke being replaced by ordinary pulverized coal. Experiments which have been made by the new process are stated to have given full satisfaction.

Organized for the purpose of making malleable castings, the Ashland Malleable Co., Ashland, O., expects to have a foundry built before Jan. 1, 1921. It is capitalized for $150,000 and will be in the market for all sorts of foundry equipment. J. H. Firestone, Spencer, O., is president; Samuel Miller, E. M. Armstrong and W. L. Rybolt, all of Ashland, are vice president, secretary and treasurer, respectively.

How Spur Gear Patterns Are Made-II

Nearly Every Type and Style of Spur Gear is Described and Illustrated Together with Practical Hints and Advice on the Construction of the Patterns

BY JOSEPH HORNER

NUMEROUS variations in the sectional forms of wheel rims, bodies, arms, and bosses, control the methods of pattern construction. The group of sections in Fig. 14 illustrates shapes that are in general use. *A* is not employed so much in pattern work as some other forms. It is chiefly confined to small gears, subject to moderate stresses, the teeth of which are cut by machines. In that case the rim is cast solid and the casting, often of steel is molded from a metal pattern. Sometimes the blanks are forgings. No large wheels are made with elliptical arms. Many small gears; those of medium dimensions, and all pinions are either solid-plated, or when the shaft occupies a large proportion of the diameter, are solid chunks.

The larger gears are usually made to the sections of *B* or *C*. *B* has arms of *T* section; *C* has a plated center which is often lightened out as at *D*, with circular holes. Vertical ribs may also stiffen the arms, as at *E*, which is an alternative to placing the ribs on the side, as at *B*. *F*, with arms of the *H* section is almost exclusively confined to machine-molded gears, where the arms are made with dry-sand cores. *G* shows how teeth are strengthened by capping or shrouding to the pitch line, the mating gear being similarly treated. *H* illustrates full-shrouding, in which case the mating wheel is not capped at all. The patternmaker can see almost at a glance how these varied shapes introduce diversities in molding, and in pattern construction. Fittings for clutches and bosses are frequently included while often, castings of two gears of different sizes and shapes are cast in one.

Fig. 15 shows a plan, and a section through a plated pattern, suitable for any diameter where a plated center is employed. In no case may a plate be made of solid stuff. If of large diameter, it must be built up with segment-sectors, as in Fig. 15, or with open joints, Fig. 16, if of moderate or small dimensions. The built-up plate in Fig. 15 includes at least two thicknesses, and preferably three. In such centers the bosses are fitted with central studs in order that stock bosses of different sizes can be interchanged. A central hole of one standard size, as say, 1½ inches, is made in all wheel patterns of this class. The rim is built in segments on the plate, Figs. 15 and 16. The plate in Fig. 16 with open joints will not shrink and cause the wheel to become elliptical, but it is not quite so rigid as the built-up plate in Fig. 15. Dowells may be fitted in the joints in the larger diameters to prevent the warping and lapping of adjacent edges.

A large pattern with a plated center is shown in Fig. 17 having half-shrouding to the pitch lines, with allowance for turning. It shows also how glued segments are reinforced with wooden pegs in the plated center; in the rim segments and in the shroudings. In building this up the actual rim segments terminate in the planes, *A*, *A*, with the ends of the teeth, which are attached to the body of the pattern. The shroudings are glued-up separately, and the lower one has to be left loose for delivery. It is fitted with a shouldered cheek, as shown, which self-centers it. The upper shroud is also left loose, being fitted with dowells and lifts with the cope. The mold has to be made in a three-part box. It is desirable to leave the top shroud loose, in order both to withdraw it from the cope instead of lifting the mold off it, and to leave the upper ends of the teeth clear for ramming the sand.

Fig. 18 shows a small plated gear, wholly shrouded, and having the central bosses and the prints fitted with studs. The shroudings of small diameter are not built in segments, but are turned from solid mahogany. This is only suitable for patterns not exceeding 6 or 7 inches in diameter. Both shrouds are dowelled to the rim. The plate must have open joints.

Figs. 19 and 20 illustrate pinions built up with radial sectors. Fig. 19 is double, and full-shrouded; the shrouds are fitted loosely to the pattern body

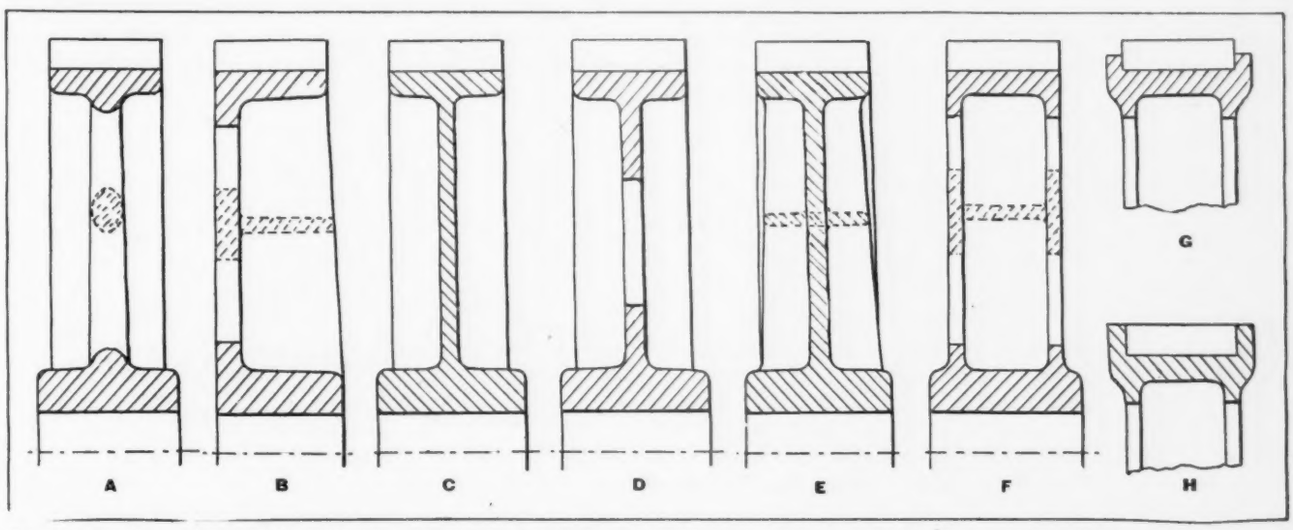


FIG. 14—A GROUP OF SECTIONS SHOWING SOME OF THE STYLES OF GEARS IN GENERAL USE—*G* AND *H* ILLUSTRATE SHROUDED WHEELS

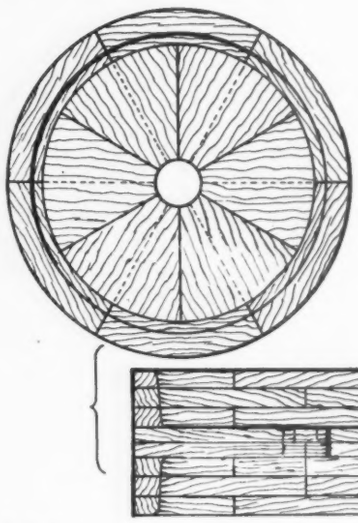


FIG. 15

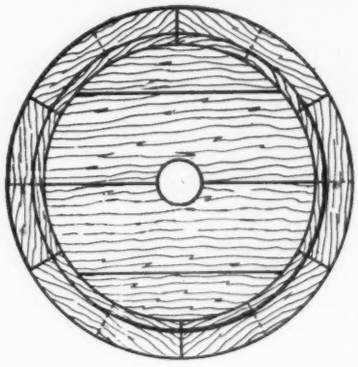


FIG. 16

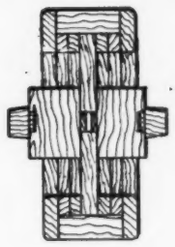


FIG. 18

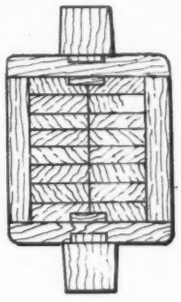


FIG. 19

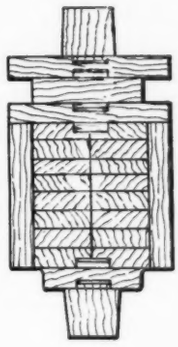


FIG. 20

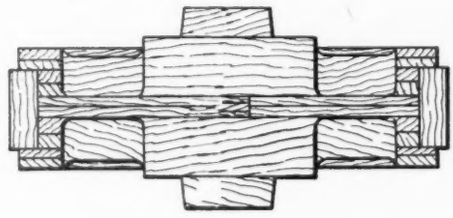
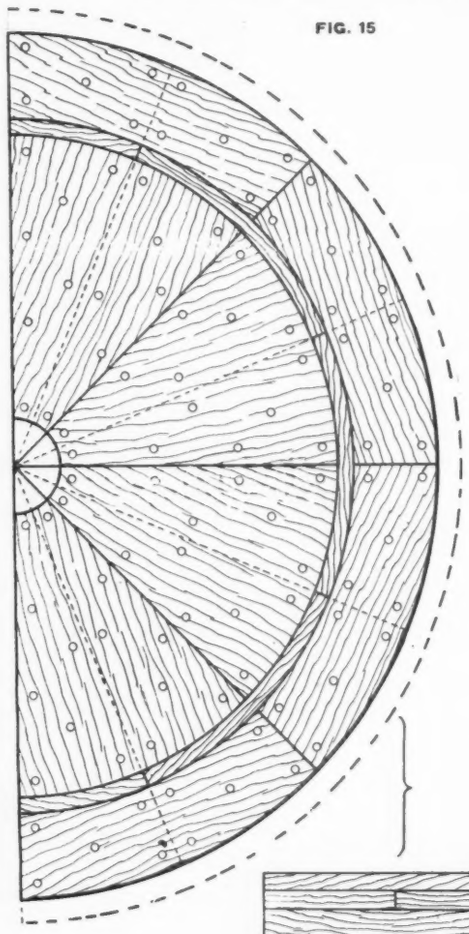


FIG. 21



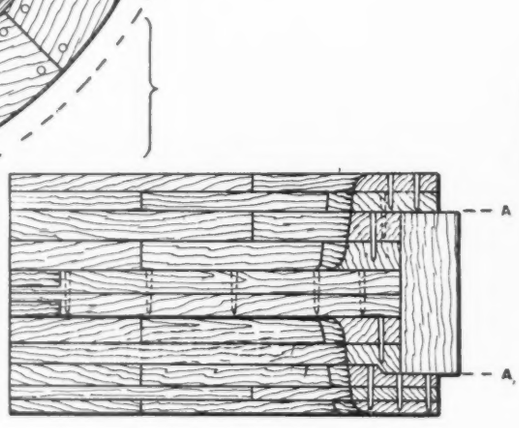


FIG. 17

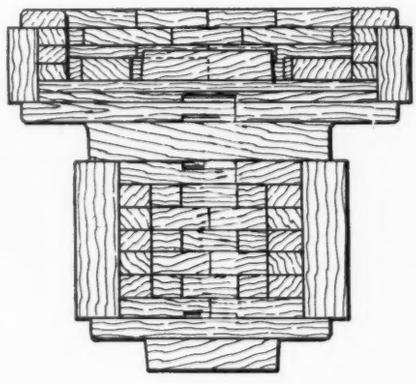


FIG. 22

FIG. 15—PLAN AND SECTION THROUGH A PLATED JOINTS FIG. 16—SAME WITH OPEN SHROUDING TO THE PITCH LINE, ALSO ALLOWANCE FOR TURNING FIG. 17—A LARGE PATTERN WITH A PLATED CENTER HAVING HALF SHROUDING FIG. 18—SHOWS A SMALL PLATED GEAR WHOLLY SHROUDED FIGS. 19 AND 20 ILLUSTRATE PINIONS BUILT UP WITH RADIAL SECTORS FIG. 21—A PLATED PATTERN WITH VERTICAL RIBS AND HALF SHROUDED FIG. 22—A CLUTCH WHEEL AND PINION EACH HALF SHROUDED

with central studs, and the prints similarly attached. Fig. 20 is full-shrouded at one end only, fitted to a sliding clutch boss, the pinion being one of those that are slid into and out of engagement with their wheels. A boss on the other end serves to terminate its longitudinal position on the shaft. All parts are attached with studs, and all except the core prints are left loose.

Fig. 21 is a plated pattern, with vertical ribs and teeth half-shrouded. The plate is built of radial sectors and each of the shroudings with two courses of sweeps; both are dowelled to the rim. The vertical ribs are attached to the bosses, to be left loose in the top. They may be fast in the bottom, or left loose.

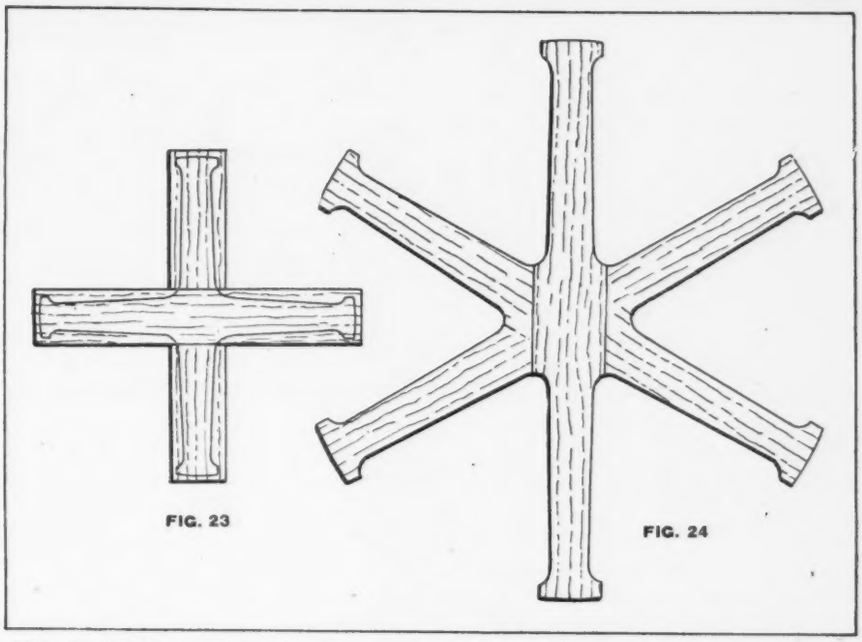
Fig. 22 illustrates a combination of a clutch wheel and a pinion, each half-shrouded to the pitch line to be cast together. All attachments are with central studs and no parts are fastened. Clutch jaws and a core print are fitted in the wheel. The shroudings are turned in solid stuff. The pinion is built-up with ring segments, making it a hollow pattern, instead of solid, as in Figs. 19 and 20.

Fitting the Arms

Gear patterns having arms are fitted in various ways. Fig. 23 shows how four arms are locked; Fig. 24, six arms; and Fig. 25 is a perspective view of the cutting of each strip. Arms must first be prepared and sunk into the rim during the building-up if they occupy the center of the rim, or subsequently to the building, if they occupy one side as in Fig. 26. Care must be taken with large wheels having light rims not to distort them by driving the arms tightly into the recesses prepared for them. They must just go in with a light hand pressure. Vertical ribs can be abutted against the bosses, or let into shallow recesses cut in the boss, or be made as a frame as in Fig. 28, and the boss be put in sectors.

Since wheel teeth of wood patterns are liable with long service to become worn, roughened-up, and displaced on their rims; and segments are subject to shrink or swell, and so produce slightly lapping joints, an excellent method is to use cast-iron rims with teeth and fit the arms in wood. This insures permanence of form of the most important portion of the pattern; materially reduces the weight to be handled; allows of making alterations in the arms if required; permits of cutting the teeth accurately in a machine; and allows the wheel teeth to be drawn through an iron stripping plate if necessary.

Fig. 29 shows arms and ribs of wood fitted with an iron rim. The top ribs, fitting in the top boss are loosely dowelled on the arms. The lower ribs are screwed permanently to the arms. The arms are not fastened to the rim in any way, but the fitting of the arms and bottom ribs within the shouldered section enables the molder to locate them correctly. Fig. 30 illustrates arms of *T* section. The flat arms and the vertical ribs are screwed together permanently, and merely laid within the rim. The molder levels them. Fig. 31 is a wheel with a plated center. This is fitted into the rim with a shoulder to center it in the absence of ribs. If ribs were fitted, the same method as that in Fig. 29 would be adopted.



FIGS. 23 AND 24 ILLUSTRATE METHODS OF MAKING THE JOINT AT THE CENTER OF THE ARMS

Familiar Types of Wheels

Succeeding Figs. illustrate combinations of wheels that are common. Fig. 32 is the pattern for a spur wheel and pinion to be cast together; the pinion

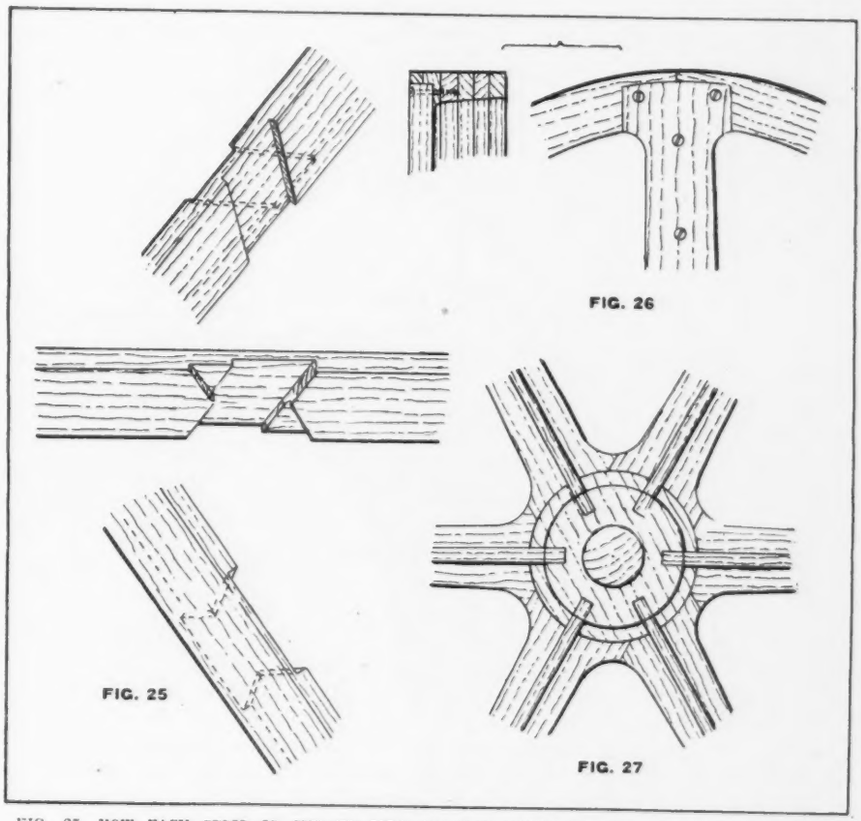


FIG. 25—HOW EACH STRIP IS CUT TO JOIN AT ARM CENTER FIGS. 26 AND 27—METHOD OF ATTACHING THE ARMS AND RIBS TO THE RIM AND HUB

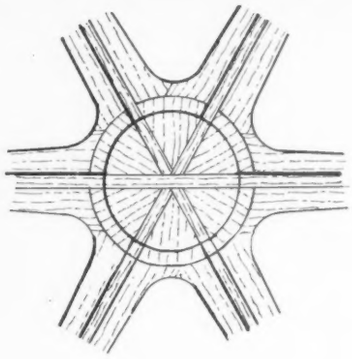


FIG. 28

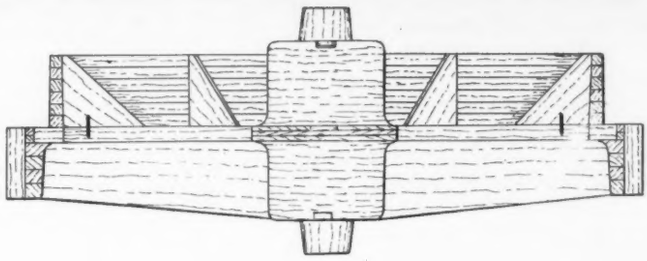


FIG. 33

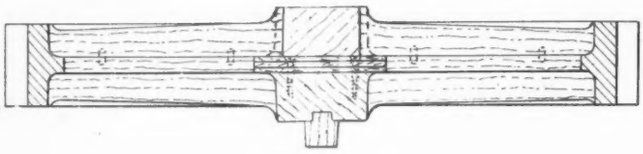


FIG. 29

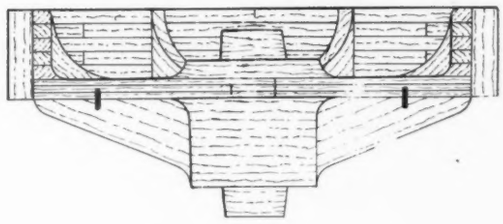


FIG. 34

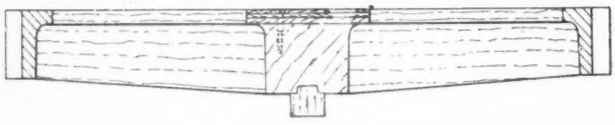


FIG. 30

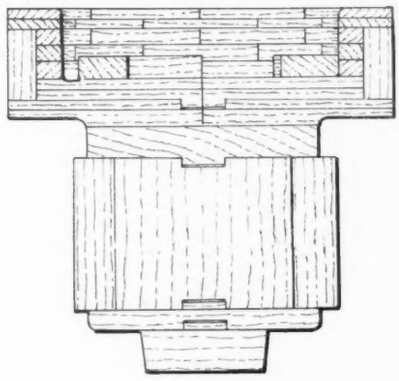


FIG. 35

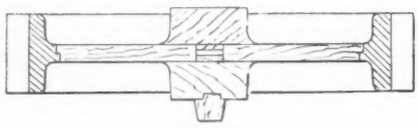


FIG. 31

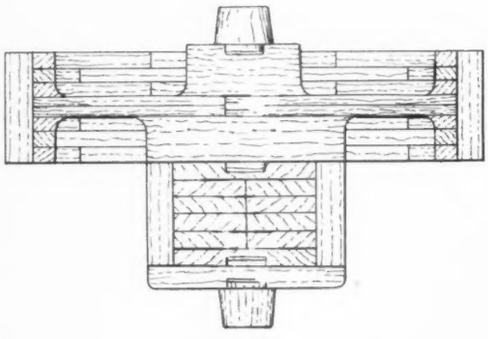
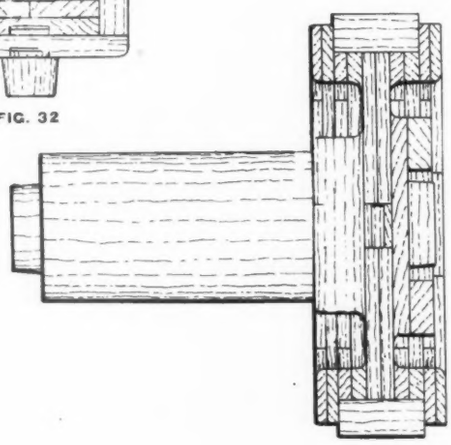


FIG. 32



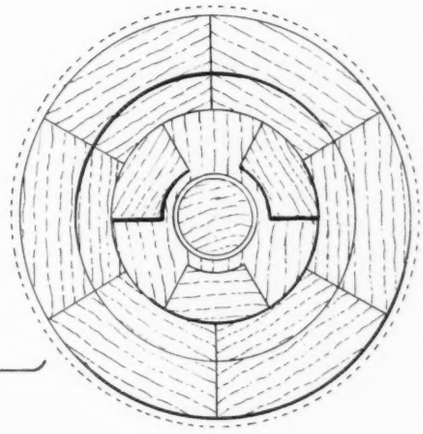


FIG. 36

FIG. 28—ATTACHING ARMS TO HUB FIGS. 29, 30, 31—ATTACHING WOODEN ARMS AND HUBS TO CAST-IRON RIM PATTERNS OF VARIOUS DESIGNS FIG. 32—A SPUR WHEEL AND PINION TO BE CAST AS A UNIT FIG. 33—A SPUR WHEEL PROVIDED WITH A BRAKE BAND FIG. 34—A SPUR GEAR WITH HUB AND ARMS ON THE OUTSIDE FIG. 35—WHEEL, DOUBLE SHROUDED, TO BE CAST WITH A HALF SHROUDED PINION FIG. 36—HALF SHROUDED WHEEL WITH CLUTCH JAWS ON ONE SIDE

being wholly shrouded to gear with the barrel wheel of a crane, remaining permanently in mesh. Each is built up with segments, and the parts all fit mutually with center studs and are left loose. Pinions and wheels of different dimensions can be readily substituted. Fig. 33 shows the rim for a band brake to be cast on its wheel. It is dowelled on the back of the wheel rim, and is stiffened with brackets screwed to the ring pattern, to come away with it in the cope. Fig. 34 is an example of a wheel, the interior of which is occupied on its shaft with the boss of another gear, which entails making the necessary length of wheel boss to stand out at the back. This, with its arms is dowelled to the plated center. The interior of the rim in the absence of arms is stiffened with brackets.

Fig. 35 shows a wheel, double-shrouded to the tooth points, to be cast with a pinion half-shrouded. The wheel and its shroudings is built-up with segments, and has clutch jaws fitted. The pinion is cut from a solid block, with the grain running axially, and its shroudings are solid. The central core is so large that no top print is included. Fig. 36 is a half-shrouded wheel with clutch jaws on one side, and a long boss on the other. The shroudings are dowelled to the wheel rim. Top and bottom prints are fitted for the central core. In all these examples the patterns are drawn as they are molded. These cover all typical cases of spur gear work.

How and Why in Brass Founding

By Charles Vickers

Match Plate Materials

We desire to obtain mixtures suitable for making match plates and follow boards.

A mixture extensively used for pattern plates, match plates and oddsides follows: Portland cement, 2 parts; plaster of paris, 1 part; sharp sand, 1 part. A different mixture that is used for more permanent work follows: Asphalt, 74 pounds; plaster of paris, 24 pounds; plumbago, 2 pounds.

For oil sand matches, various mixtures are in use. The following is good: Finely sifted gangway sand, 89 parts; fine iron borings or turnings, 1 part; litharge, 3 parts. Mix dry and add sufficient linseed oil to dampen the mass; a little water also may be added.

For metal pattern plates, an alloy of aluminum, 93 per cent; copper, 7 per cent, is suitable, sometimes antimony or bismuth is added in small percentages to counteract the shrinkage. A low melting white metal for pattern consists of the following: Tin, 55 per cent; zinc, 44 per cent; bismuth, 1 part.

Facing Sand Mixtures

We desire to obtain a facing-sand formula for use in molds for bronze gears and worm wheels weighing from 60 to 125 pounds each. We have been making these castings in green sand, but have found the sand teeth of the mold are cut away by the molten metal.

The following is an excellent facing for all brass castings of the weight mentioned. The sands should be dry before they are mixed. Take new, fine molding sand, 10 parts; fine silica sand, 5 parts; ground clay, 1 part. For green sand work, the mixed dry sands should be dampened with water only, and should be ground together in a mill. For dry sand work, mix the dry sands with molasses water, or with glue water, and spray the molds well with molasses water after the patterns have been withdrawn and the mold has been finished. Afterwards, bake the molds in an oven, or skin dry them with a gasoline torch, or other source of heat.

Bronze worm wheels generally are made in chills, not in sand, as the chill produces a much finer grained metal than the sand mold. Both cast-iron molds and carbon molds are used. Worm wheels with the teeth cast in are made in metal dies, which are handled by machines. Perfect castings, true to size, with a minimum of finish are made thus.

Melting Brass in an Oil-Fired Furnace

In melting brass in an oil-fired furnace we have experienced difficulty from porosity in the castings. The holes are not seen until after the castings are machined. Can you advise us what to do to avoid this difficulty?

This difficulty may be caused by melting too rapidly and it will be advisable to try a less oxidizing flame on a few heats. The air supply can be reduced, or the oil supply can be increased according to circumstances. At the same time it will be well to use a molten cover on the brass, such for instance as green bottle glass.

The glass will melt and cover the surface of the brass that is molten in the crucible, and thus keep the furnace gases from the metal. If the gas is unable to get in contact with the metal it cannot be absorbed, and if no gas is absorbed, the castings will be solid.

Some Causes for Defects in Aluminum

We are sending for examination a sample aluminum casting which in service forms the base or body for an electric cleaner. You will note the casting is pitted and we wish to learn if this is caused by hard cores, some foreign substance in the metal, or is it due to the heavy section of the defective part? The alloy we use is regular No. 12. It is being poured at a temperature of 1375 to 1425 degrees Fahr. The aluminum is melted in an iron pot and is poured with a small hand ladle. A flux of sal ammoniac is used on the aluminum. The castings are molded on machines; the sand is regular aluminum molding sand. The face of the casting is made in the drag as the construction of the casting makes it impossible to cast it otherwise. Any information you may be able to give us will be appreciated.

An examination of the casting shows the following defects: (1) sand holes from the mold; (2) intercrystalline shrinkage; (3) cracking; (4) abraded core.

The sand holes are caused by breaking the mold when it was closed. The holes on the extreme ends of the suction part are due to this cause. The casting is awkwardly constructed at this point owing to the projecting lug. It will pay to consider carefully the feasibility of changing the pattern at this part; either carrying the lug in a core, or changing the contour of the pattern. If no change is considered possible, a heavy production loss must be figured as part of the cost of adhering to this particular shape. Out of every hundred castings made, a cer-

tain percentage will be defective because of crushing the sand when closing. It is no reflection on the molding that these sand holes are found at this point.

The second defect is intercrystalline shrinkage. This shrinkage is peculiar to aluminum alloys. Its effect is to produce the angular depressions scattered over the surface of the casting and it is caused by the separation of the rich copper-aluminum eutectic from the crystalline part of the alloy. The eutectic is the most fluid part of the alloy. In pouring a mold if the gate is attached to a thin section, a choking effect is produced as a result of which the less fluid portion of the alloy is strained out. The more fluid metal fills out the more remote parts of the mold, while the less fluid lodges in the parts adjacent to the gate and when the alloy solidifies, as the eutectic part of the less fluid metal has been removed to a considerable extent, there is nothing to fill the voids between the crystals after the latter have formed. The result is the formation of angular-shaped depressions on the surfaces of the casting. These depressions, it will be noted, resemble the copper-aluminum eutectic as shown in photomicrographs of the alloy.

The difficulty can be remedied by a better distribution of the gates to fill all parts of the casting, or mold about the same time, thus avoiding the flow in the alloy. One of the most satisfactory ways of running aluminum castings is through drop gates the size of a lead pencil, distributed uniformily over the mold shape. If possible, this would cure two troubles, the angular cavaties and the cracking. How to get this more uniform distribution of the metal throughout the mold is a problem to which it will pay to devote much time and thought.

The third difficulty of the casting is cracking. This is caused by pouring the molds at too high a temperature. No doubt, the alloy must be very fluid to fill the casting from one gate. If the temperature of the aluminum when poured exceeds 1300 degrees Fahr., the percentage of cracked castings will increase with the temperature. At 1400 degrees and over, the cracking losses will be high. To run the molds with metal under 1300 degrees temperature requires a rapid filling, for this light section, and brings up once more the problem of a better adjustment of the gates.

The fourth fault found, namely abraded cores is easily remedied. If the cores are too soft externally to able them to be handled without crumbling, they should be sprayed before being dried with some glutinous binder such as molasses water or glue water. This will harden the surface to permit handling the cores without breaking them.

Flour Facing for Molds

We would like to learn what material is best to use as a coating for molds for brass castings. In making iron castings we use graphite mixtures which are applied to the mold in order to obtain a smooth, clean casting. We want to use in the case of brass in order to obtain castings, clean sand and dirt, and of the natural color of the brass.

In making molds for the reception of brass or bronze, the weight of the casting and the character of the alloy determine what coating or facing shall be applied to the mold. The majority of brass castings are cast in green-sand molds which are coated with ordinary flour. This is dusted on the mold through a cloth bag. If a very nice casting is wanted the flour is dusted on the mold twice, and after each application it is blown off with a bellows. This coating of flour causes the sand to *peel* from the brass casting. If the brass is composed of metals clean and free from iron, a clean, orange-colored casting is obtained. Iron in the alloy makes the casting black when it is taken from the sand. Phosphorus, also, makes dark colored castings. Massive bronze castings usually are coated with a greenish scale if the molds are not coated. They rarely possess the orange color. Therefore, it is usual to coat such molds with graphite, the same as in the case of iron. The graphite prevents the brass from sinking into the mold surface, producing a rough casting. Molds for heavy phosphor-bronze castings should be coated with liquid graphite, then dried before they are poured. This insures smooth castings.

Sulphur and Brass

Will you please advise us what action coke containing 2 per cent sulphur will have on brass or bronze melted in a No. 70 crucible? The furnaces are the pit type and the sulphur coke is used as fuel. Also can you offer suggestions for counteracting the effects of the sulphur?

Sulphur has the effect of producing spongy castings. This is because it reacts with oxygen or oxides to form a gas that is soluble in copper alloys. This gas simply aerates the metal, operating along the same lines as yeast in dough. To use a high-sulphur fuel means that greater care in melting is necessary to get solid castings, for if the metal is not protected from sulphur, or the gases formed in the furnace by burning sulphur, it will absorb the same, and retaining it when solid produce castings filled with holes.

A little calcium chloride placed in the bottom of the crucible has been found useful in preventing trouble when high-sulphur fuels are being used. The use of some cover on the metal also is advisable. Glass is often used, as it melts and makes a tight cover over the metal. If no difficulty is experienced with spongy castings, continue with the scheme of careful melting, and possibly no difficulty will be experienced. Sulphur alone, minus oxygen does not produce spongy castings; it has been added to the alloy 88-10-2 with the result the metal appeared to be rendered more dense. However, it darkens the skin of the castings and is likely to produce spongy castings with great ease. Therefore it is better to keep the sulphur as low as possible when melting copper or its alloys.

Manganese Bronze Formula

We would like to obtain your advice in regard to the best formula to use for making manganese bronze, as well as instruction for making this alloy. Please inform us if scrap metals can be used, and what amount of manganese should be added to the new metals.

Regarding the best formula for manganese bronze and the best method of making the alloy, there are as many opinions as there are manufacturers of this metal, each one believes he has the best method until he falls down and contemplates some big loss, then is not so sure about the matter. For the amateur maker of manganese bronze the following alloy gives good results: Copper, 46 pounds; manganese copper containing 30 per cent manganese, 12 pounds, zinc, 40 pounds, and aluminum, 2 pounds. Melt the copper and the manganese copper together, then add the aluminum. Follow with the zinc, and ingot the alloy. Remelt the ingots to make the castings. If greater ductility is desired than this alloy will give, decrease the aluminum to 1 per cent and increase the copper correspondingly. This alloy cannot be made from scrap metals. Nothing except new metals and high-grade zinc can be used. While the skillful metallurgist can utilize scrap metals to excellent advantage in making manganese bronze, it is not wise to attempt this until well acquainted with the peculiarities of the alloy, and this requires years of study. For this reason we suggest the alloy given above. It is expensive, but excellent results can be obtained in making it if ordinary precautions are followed while melting.

Electrical Melting Of Alloys---XIII

Future of the Electric Furnace in the Alloy Industry Is Considered as a Whole and in Reference to the Different Types of Furnaces and the Possibilities of Each Class

BY H. W. GILLETT

WHEN, eight years ago, the writer began to study the possibilities of electrical melting of brass there was no commercially successful electric brass furnace in the world, and what few ideas there were as to how such a furnace should be built, were in a most embryonic state. Even the need for such a furnace was but hazily understood. Attention was focused on this need in December, 1911, when a symposium on mineral wastes that had been arranged by C. L. Parsons, in his capacity as secretary of the American Chemical society, was held*. At this symposium the magnitude of the loss of zinc in the brass industry was emphasized. In his capacity as chief chemist of the bureau of mines, Dr. Parsons gave his official attention to this condition. Solution of the problem by electric furnaces was then merely a hope. The resulting study** of the situation showed a real need for electric melting. From 1913 to 1916 there was considerable experimental work done on the subject by several workers, and successful electric furnaces became a probability. By the end of 1917 enough foundry work had been done with electric furnaces to show that they were adapted for the work. The years 1918-1919 brought commercial experience with the furnaces. This resulted in rapid improvement so that in 1920 it is hardly possible to keep up to date a list of electric brass furnaces in commercial use, so rapidly are new installations made.

The rate of growth of electric brass melting has been so great as to prove that it meets a real commercial need sufficiently well to be a good investment for the industry as a whole. It is certainly of interest, and possibly of value, to speculate on the probable trend of future development of this melting process. Enough development has been done to indicate the possibilities of the various furnaces.

First of all, we may be sure that unless and until some undreamed of development of the future relegates all present electric furnaces to the scrap-heap, there will always be a use for several different types, rather than a monopoly by any one so called *best* electric brass furnace. The nonferrous industry is too ramified and the alloys handled are too different for any one type of furnace to command the situaton, as the direct-arc type predominates in electric steel melting.

However, we may look for a closer fitting of the furnace to the job. Pending the development of the various present types, some of the early users took the first electric furnace available that would handle their work, it being then more a question of a comparison of some particular electric furnace against fuel furnaces than one of comparing several electric furnaces with fuel-fired ones and with each other. Once having an electric furnace installed and finding it to be better than fuel-fired furnaces, when a new furnace was to be put in, familiarity with the operation of the first one has sometimes made it simpler to install another of the same type instead of trying another type, so that the evidence of repeat orders, while important, is not always final.

It is a hopeful sign that so many plants are now trying more than one type. Sooner or later accumulated experience, especially that of plants operating more than one type of furnace, will make it possible to delineate far more clearly than this series of articles has been able to, the different sets of conditions under which each type of furnace will do its best work. The fundamental principles of furnace efficiency are, however, pretty definite and, arguing on the ability of the different types of furnace to meet those principles, it seems to the writer that future electric brass furnace development is not likely to show any rapid change in the relative installation and use of the different types. The direct-arc type should maintain its lead for melting monel metal and similar alloys that are really as close to steel as they are to brass as far as their behavior on melting goes, but direct-arc furnaces even for melting bronze will probably remain rarities.

The stationary indirect-arc type should, as now, fill a small field on bronzes and red metal, but it will probably remain in a minor position.

The induction furnace should, by virtue of its efficiency, hold first place in the task of melting yellow brass 24 hours a day, and as the size of the furnace of this type becomes larger, its grip on this field should become even more secure. If it can be developed to handle alloys high in lead without damage to the lining, and if it can be designed to handle alloys high in copper, and hence of low electrical resistance, without giving too low a power factor, it may find a still wider range of usefulness. It will always have to give way to the other types when suc-

PROPHECY of future developments of the electric furnace may be made along certain lines from a fundamental knowledge of the industry. For instance a prediction can be made with fair accuracy in regard to the future results of the competition of the electric furnace with the fuel-fired furnace, but even this must be modified to allow for unexpected improvements in the fuel-fired furnace. The different types of electric furnaces for melting alloys have been outlined as to their spheres and future expansion. However, the entire trend of one class of furnaces might be changed by some unforseen development. This is illustrated by the history of steel melting furnaces. At first the induction and the direct-arc types competed for supremacy until the arc-type furnace demonstrated decided advantages and replaced the induction furnace almost entirely. While this might have been considered conclusive, a prominent manufacturing company at present is experimenting with induction furnaces and the supremacy of the induction furnace over the arc-type furnace in steel-making is yet a possibility.

*Bassett, W. H., Zinc Losses, Jour. Ind. and Eng. Chem., Vol. 4, 1912, p. 164.
Parsons, C. L., Discussion, Metal Ind., Vol. 10, 1912, p. 240.
Parsons, C. L., Notes on Mineral Wastes, Bull. 47 Bur. Mines, 1912, p. 20.

**Gillett, H. W., Bran Furnace Practice in the United States, Bull. 73, bureau of mines, 1916.

cessive heats of widely different alloys have to be handled. Its needs as to refractories and to its construction in larger sizes will undoubtedly be ultimately met. The design of a furnace of this type which can be completely emptied of molten metal and started up again will probably not be accomplished.

The rocking indirect-arc type, because of its combination of versatility and efficiency, is likely to be called upon to do an increasingly large proportion of the melting in what might be termed the average foundry. The writer looked for the wide application of automatic electrode control to these furnaces, as well as to the stationary indirect-arc and direct-arc furnaces used on brass and bronze, though seldom in plants where the installation consists of only one furnace.

Automatic Control Advantageous

The development of an automatic electrode control device that will work as satisfactorily in the atmosphere of zinc vapor, obtained from the furnace when melting alloys high in zinc, as it does when handling red brass or bronze, is desirable since present devices are not likely to be wholly satisfactory in such service. This development will doubtless be made as experimental work in this direction is now under way.

Whether the rocking indirect-arc type will be used in sizes much above one ton capacity, is hard to predict. It is quite possible that a larger, polyphase form of this type, which is being developed, would be useful in smelting and refining plants, but it is doubtful whether this larger furnace would be an improvement for the ordinary foundry. Whether there will be much use of the tinier furnaces of this type is a question. The writer doubts it.

The future standing of the types so far mentioned seems pretty clear. That of the reflected heat type is less certain. There will always be a field for furnaces of this type, but whether the present leader, the granular resistor form, will be able by virtue of its simplicity and reliability to continue to offset its inability for rapid production and its lack of thermal efficiency, against the competition of higher powered and more rapid and efficient furnaces remains to be seen. The opportunity for improvement in the latter forms of reflected heat furnaces is probably greater than in the granular resistor form. With better refractories, decided improvements may come.

With the inevitable future development of hydroelectric power the relative cost of electricity compared with fuel, will decrease. The importance of thermal efficiency, i.e. low power consumption per ton, will then be less, though it will never be negligible. Constructive legislation looking toward water power development has at last been passed and approved though it will take time to develop the various hydroelectric projects thus made possible and to get them into operation.

Various plans and suggestions have been made for an improvement in the power situation, notably that of Ex-Secretary Lane* for the tying-in together of the steam and water power plants of the eastern seaboard. The development of the proposed St. Lawrence river** to allow ocean vessels to pass would furnish the United States about 800,000 kilowatts of hydroelectric power free from seasonal variations due to low water. The bulk of the hydroelectric developments is, of course, expected in the west, but the schemes cited above show that the east may also improve its power situation. However, all such development require the expenditure of huge amounts of capital*** and take years for completion.

It seems to the writer that unless hydroelectric development comes at a far more rapid rate than is now expected, so that power prices tend to fall at once, the lower efficiency of the reflected-heat type furnaces will tend to bring about, for the immediate future, increased attention to the operation of this type at least 16 hours out of 24. This condition will also induce a less rapid extension of their use in foundries operating on a single shift only.

The need of the granular-resistor type for a resistor trough that will allow the use of a high enough rate of power input to raise the efficiency of the furnace, unfortunately does not seem to likely to be met. The substitution of the *zig-zag* solid resistor for the granular resistor may help, but its value has still to be proved.

Really extended use of the Northrup high frequency eddy current furnace depends primarily on the availability and the cost of high frequency alternators. This furnace is likely to be a commercial standard in 10 years, but it is hard to see how with even the most rapid electrical engineering developments in high frequency current it can become of prominence for large-scale commercial work in the immediate future. It will probably hold a commanding position in small-scale work, as it is the only type that can operate efficiently on small intermittent heats.

If the Bennett contact-resistance furnace is to be sold to firms other than its present exclusive users it may be found to deserve wide use, but with the present lack of knowledge as to its performance no appraisal of its relative merits is possible and no predictions can be made. Of the various other furnaces under development for brass some may have points of merit that will give them a place in commercial work, but it seems unlikely that anything very startling will result from them. It is of course possible that some quite unknown or unrecognized advantage of one of these types of furnace or of some brand new furnace might alter the whole future trend of electric brass melting. However this is a possibility rather than a probability.

Advances in knowledge of refractories and greater availability of better refractories for electric furnace use will come, but progress in this line is likely to be gradual rather than rapid. It is only reasonable to expect also that the future will show an increase in the quality and uniformity of graphite electrodes used by so many electric brass furnaces, as well as a decrease in their cost. Minor advances in construction, rather than in basic design, due to accumulated experience, will be made in all types.

Improvements in general bid fair to be in the nature of refinement of details of the furnaces themselves, in the proper application of existing types to different conditions, and in better operation of present furnaces, rather than in any sweeping changes. One radical change in operation is, however, quite possible. That is the preheating of the charge by fuel outside the electric furnace, and the finishing of the heat in the electric furnace. Theoretically this would show a marked advantage, but it has obvious practical disadvantages. It would be easiest to apply satisfactorily in smelting and refining plant practice, and should be of value there.

Design for Top Charging

If such preheating works out well enough in practice to deserve wide application, it will give a still greater advantage to that already held by the furnaces that can be mechanically charged from the top, since the hot material would have to be charged in this manner. It also would probably cause changes in the design of other furnaces so as to allow top charging.

Auxiliary devices and equipment, such as bundling and briquetting machines, automatic charging devices, pouring systems in which large ladles may be used and the stream of metal directed with the same ease and accuracy as from a small ladle, developments to allow the use of larger molds or to

*Anon, Secretary Lane's Proposal for Power Resource Survey, El. World, Vol. 73, 1919, pp. 282-331.
See also Murray, W. S., Economical Supply of Electric Power for the Industries and Railroads of the Northern Atlantic Seaboard, Jour. Am. Elect. Eng., Vol. 39, 1920, p. 219.

**Economical Power, the Strongest Agent for Maintaining Supremacy in World's Trade, Jour. Am. Inst. Elec. Eng., Vol. 39, 1920, p. 27.

***Compare Dunn G., The Water Power Situation, Including its Furnace Aspect, Trans. Am. Inst. El. Eng., 1916, p. 575.

pour small ones more quickly when the metal is poured direct from furnace to mold, mold conveyors, etc, will be developed further and be fitted into the operation of electric furnaces as the advantage of these appliances in increasing production is more clearly understood.

The writer cannot see much likelihood of any great advance along the line of carrying the furnace bodily to the molds, save under quite unusual conditions. However, there will be need for an efficient electrically heated ladle heater, by which the ladles are heated from the inside, for cases where a plant wishes to go on an entirely electrical basis.

It should not be long before smelting and refining plants operate electric furnaces for making all sorts of brass ingot from scrap, almost to the exclusion of fuel-fired furnaces. This is so because of the ability of the electric furnace to handle large melts and to avoid metal losses, and because plants so equipped can readily operate 24 hours a day and thus take full advantage of the savings effected by continuous operation.

Almost complete electrification of melting in the wrought-brass industry should follow. The conservatism of this industry has been much commented on, but the writer suspects that this is more apparent than real. At any rate, most of the rolling mills for whom their competitors have the most respect have gotten well along toward melting entirely by electricity with such good results that this example is likely to be widely followed by their competitors.

The foundries of large manufacturing plants, and the larger jobbing foundries will doubtless rapidly continue to be equipped for electric melting wherever the cost of electric power is low enough to allow it. In fact, there seems no good reason why the electric furnace, within the next year or so, should not be melting as much of this country's brass and bronze, as is melted in fuel-fired furnaces, and unless conditions change materially the electric furnace should ultimately handle some 90 per cent of this work. It is not impossible that electric melting may have some effect on the geographical location of the brass industry, since the availability of cheap hydroelectric power is a factor that will hereafter have to be considered in the location of a plant.

The saving to the country in metal losses, in crucible cost, in fuel and its transportation, in labor, and by the advantage of substituting a less hot and less arduous method of melting for the older ones, is not inconsiderable even at the present time, and it will become larger as time goes on. This saving will certainly be large enough to justify the time and expense that has been put upon the problem in the last few years by so many investigators.

Outlines Properties of Die Castings

BY CHARLES PACK

DIE castings may be defined as castings made by forcing molten metal, under pressure, into a metallic mold. The die casting process is best adapted to alloys of comparatively low fusing points which may, for convenience, be divided into the following groups:

Zinc alloys, consisting of zinc alloyed with tin, copper, or aluminum; tin alloys, consisting essentially of tin alloyed with copper, lead, or antimony; lead alloys, consisting essentially of lead alloyed with tin or antimony; and aluminum alloys, consisting essentially of aluminum alloyed with copper.

A typical zinc alloy for die castings is that whose composition is zinc, 87.5; tin, 8; copper, 4; and aluminum, 0.5 per cent. Castings made from this alloy should not be used for parts that are subjected to severe stress or sudden shock in service.

The five compositions given below are typical die casting alloys of the tin group:

	Tin Per Cent	Copper Per Cent	Lead Per Cent	Antimony Per Cent
No. 1	90	4.5	0	5.5
No. 2	86	6	0	8
No. 3	84	7	0	9
No 4	80	0	10	10
No. 5	61.5	3	25	10.5

Alloy No. 1 is a so-called "genuine babbitt" metal and was used very extensively during the war for mainshaft and connecting-rod bearings on all American-made airplanes and motor trucks. No. 2 is somewhat harder and is used extensively for bearings in internal combustion engines. No. 3 is somewhat harder than alloy No. 2 and is the S. A. E. standard for high grade internal combustion engine bearings. No. 4 is in general use for light bearings on stationary motors. No. 5 is a bearing metal for light duty and is used on a large number of moderate priced automobiles for mainshaft and connecting rod bearings.

Tin alloys find their largest field of application in their use as bearings for internal combustion engines. They are also used for other purposes where a tensile strength of over 8000 pounds per square inch is not essential and where resistance to corrosion is of importance. They are not affected by water, weak acid, or alkaline solutions, and when free from lead, are extensively used for food container parts.

Selecting Lead Alloys

The following four compositions are those of lead alloys widely used in the production of die castings:

	Lead Per Cent	Tin Per Cent	Antimony Per Cent
No. 1	83	0	17
No. 2	90	0	10
No. 3	80	10	10
No. 4	80	5	15

Alloy No. 1 is generally known as C. T. metal, due to its extensive use in the manufacture of coffin trimmings. This alloy is also a good bearing metal for light duty and is employed for thrust washers and camshaft bearings on light internal combustion engines. No. 2 is somewhat softer and more ductile than No. 1. No. 3 is much used for light bearing duty, being somewhat tougher and stronger than Nos. 1 and 2. No. 4 is somewhat harder than No. 3 but less ductile. Many similar alloys may be compounded, all of which may be die cast readily.

Lead alloys may be used where a metal of noncorrosive properties is desired and where a tensile strength of not over 8000 pounds per square inch will suffice. They should not be used for parts that may come in contact with foods or that may be handled often in service, since the poisonous properties of lead and lead alloys are well known.

A typical aluminum alloy for use in die casting work has the following composition: Aluminum, 92 per cent; copper, 8 per cent.

The alloy is well known in the arts as No. 12 alloy and is used very extensively for automobile and airplane parts. By varying the copper content harder or softer alloys may be obtained, all of which may be die cast successfully. Aluminum die castings find wide employment in the manufacture of parts of automobiles.

The cost of die castings cannot be computed on the pound basis since it depends on the design of the piece, the number and position of the cores, the quantity to be produced and certain other factors. For comparative purposes it may be stated that at the present time tin alloy castings are the highest in cost, being followed by those of aluminum alloy, zinc alloy, and lead alloy in the order named.

From a paper presented at a recent meeting of the American Society of Mechanical Engineers. The author, Charles Pack, is chief chemist, Doehler Die Casting Co., Brooklyn.

A. F. A. Exhibits to Establish Record

More Display Space Sold for Columbus Convention than on Any Previous Occasion —Large Attendance Expected to See Latest Foundry Equipment and Appliances, and to Hear Technical Papers

PROSPERITY and growth of the casting industry will be reflected in the exhibits to be presented to the attention of the visitors to the annual convention of the American Foundrymen's convention to be held in Columbus, O., Oct. 4 to 8. Already the highest previous record for space occupied by exhibitors, made at the convention in Philadelphia last year when 60,000 square feet were taken, has been passed by nearly 15 per cent. A list of exhibitors registered up to Aug. 10 is appended. The number is constantly increasing and promises to be well over 200. The complete list giving the location of the different exhibits together with a description of the appliances to be exhibited by each company and the names of the men in charge of the various booths, will be published in full in the Sept. 15 issue of THE FOUNDRY.

An interesting program of papers is being prepared under the direction of the committee on papers, W. R. Bean, Eastern Malleable Iron Co., Naugatuck, Conn., chairman. The Ohio State fair grounds, at which the convention is to be held, have large and well appointed buildings for the exhibits as well as auditoriums for the technical meetings, and Columbus will afford ample hotel accommodations for those attending the meeting. A larger gathering than usual is expected due to the interesting program and the large volume and assortment of exhibits, together with the central location of Columbus which is not more than a night's journey from nearly all the manufacturing centers east of the Mississippi. A number of entertainment features also are being arranged.

List Of Exhibitors Registered For Columbus Show

Acheson Graphite Co., Niagara Falls, N. Y.
Air Reduction Sales Co., New York.
Ajax Metal Co., Philadelphia.
Akron Cultivator & Mfg. Co., Akron, O.
American Boron Products Co., Reading, Pa.
American Foundry Equipment Co., New York.
American Hominy Co., Indianapolis.
American La France Fire Engine Co., Pittsburgh.
American Molding Machine Co., Terre Haute, Ind.
American Woodworking Machinery Co., Rochester, N. Y.
Arcade Mfg. Co., Freeport, Ill.
Asbury Graphite Mills, Asbury, N. J.
Ashland Brass Foundry, Ashland, O.
Atkins, E. C., & Co., Indianapolis.
Austin Co., Cleveland.

Bacharach Industrial Instrument Co., Pittsburgh.
Baker Bros., Toledo, O.
Barrett-Cravens Co., Chicago.
Bauer, A. E., & Son, Chicago.
Bausch & Lomb Optical Co., Rochester, N. Y.
Beaudry & Co., Boston.
Berkshire Mfg. Co., Cleveland.
Birkenstein, S., & Sons, Inc., Chicago.
Black Diamond Saw & Machine Co., Natick, Mass.
Blaw-Knox Co., Pittsburgh.
Blystone Mfg. Co., Cambridge Springs, Pa.
Booth Electric Furnace Co., Chicago.
Brass World Publishing Co., New York.
British Aluminum Co., Ltd., New York.
Brown Instrument Co., Philadelphia.
Buckeye Products Co., Cincinnati.

Carborundum Co., Niagara Falls, N. Y.
Cawaard Gaskill-Furnace Corp., Chicago.
Champion Foundry & Machine Co., Chicago.
Chase, Frank D., Inc., Chicago.
Chase Foundry & Mfg. Co., Columbus, O.
Chesapeake Iron Works, Baltimore.
Chicago Pneumatic Tool Co., New York.
Clark Tructractor Co., Buchanan, Mich.
Cleveland Flux Co., Cleveland.
Cleveland Pneumatic Tool Co., Cleveland.
Clipper Belt Lacer Co., Grand Rapids, Mich.
Coale, Thomas E., Lumber Co., Philadelphia.
Combined Supply & Equipment Co., Buffalo.
Corn Products Refining Co., New York.
Curtis Pneumatic Machinery Co., St. Louis.
Chicago Crucible Co., Chicago.
Cooper Mfg. Co., York, Pa.

Daily Iron Trade and Metal Market Report, Cleveland.
Davenport Machine & Foundry Co., Davenport, Iowa.
Davis Bournonville Co., Jersey City, N. J.
Dayton Pneumatic Tool Co., Dayton, O.
Detroit Electric Furnace Co., Detroit.
Diamond Clamp & Flask Co., Richmond, Ind.
Dings Magnetic Separator Co., Milwaukee.
Disston, Henry, & Sons, Inc., Tacony, Philadelphia.
Dixon, Joseph, Crucible Co., Chicago
Doggett, Stanley, Inc., New York.

Electric Furnace Co., Salem, O.

Federal Foundry Supply Co., Cleveland.
Federal Malleable Co., West Allis, Wis.
Firefoam Service & Supply Co., Cleveland.
Foreign Crucibles Corp., Ltd., New York.
Foundry Equipment Co., Cleveland.
THE FOUNDRY, Cleveland.

Gardner Machine Co., Beloit, Wis.
Geirt Mfg. Co., Atlantic City, N. J.
General Electric Co., Schenectady, N. Y.
Gordon, Robert, Inc., Chicago.
Great Western Mfg. Co., Leavenworth, Kans.
Great Western Smelting & Refining Co., Chicago.
Grimes Molding Machine Co., Detroit.
Gurney Ball Bearing Co., Jamestown, N. Y..

Hardy, Clement A., Co., Chicago.
Hardy, F. A., & Co., Chicago.
Harris, Benjamin, & Co., Chicago.
Haskins, R. G., Co., Chicago.
Hauck Mfg. Co., Brooklyn, N. Y.
Hausfeld Co, Harrison, O.
Haynes Stellite Co., Kokomo, Ind.
Heald Machine Co., Worcester, Mass.
Hill-Brunner Foundry Supply Co., Cincinnati.
Hill & Griffith Co., Cincinnati.
Hoevel Mfg. Corp., Jersey City, N. J.
Holland Core Oil Co., Chicago.
Humphreys, E. C., & Co., Chicago.

Independent Pneumatic Tool Co., Chicago.
Industrial Electric Furnace Co., Chicago.
Ingersoll-Rand Co., New York.
International Molding Machine Co., Chicago.
Interstate Sand Co., Zanesville, O.
Iron Age, New York.
Iron Trade Review, Cleveland.

Jones Sand Co., Columbus, O.

Kawin, Charles C., Co., Chicago.
Keener Sand & Clay Co., Columbus, .
Keller Pneumatic Tool Co., Chicago.
Kellogg, Spencer, & Sons, Inc., Buffalo.
Kelly, T. P., & Co., Inc., New York.
King Refractories Co., Inc., Buffalo.
Kinsey, E. A., Co., Cincinnati.
Knoeppel, C. E., & Co., Inc., New York.

Lakewood Engineering Co., Cleveland.
Lane, Henry M., Co., Detroit.
Lindsay Chaplet & Mfg. Co., Philadelphia.
Link Belt Co., Chicago.
Louden Machinery Co., Fairfield, Iowa.
Lucas Machine Tool Co., Cleveland.
Lupton's, David, Sons Co., Philadelphia.

McCormick, J. S., Co. Pittsburgh.
McLain's System, Milwaukee.

MacLean Publishing Co., Toronto, Ont.
MacLeod Company, Cincinnati.
Magnetic Mfg. Co., Milwaukee.
Mahr Mfg. Co., Minneapolis.
Malleable Iron Fittings Co., Branford, Conn.
Marden, Orth & Hastings Co., Inc., New York.
Maxon Furnace & Engineering Co., Muncie, Ind.
Menefee Foundry Co., Fort Wayne, Ind.
Metal Industry, New York.
Metal Saw & Machine Co., Springfield, Mass.
Metal & Thermit Corp., New York.
Michigan Smelting & Refining Co., Detroit.
Milburn, Alexander, Co., Baltimore.
Monarch Engineering & Mfg. Co., Baltimore.
Mott Sand Blast Mfg. Co., Brooklyn, N. Y.
Mumford Molding Machine Co., Chicago.
National Engineering Co., Chicago

National Scale Co., Chicopee Falls, Mass.
Nicholls, William H., Co., Inc., Brooklyn, N. Y.
Norma Co. of America, Long Island City, N. Y.
Norton Co., Worcester, Mass.

Obermayer, S., Co., Chicago.
Ohio Body & Blower Co., Cleveland.
Ohio Equipment Co., Cleveland.
Oldham, George, & Son Co., Philadelphia.
Oliver Machinery Co., Grand Rapids, Mich.
Osborn Mfg. Co., Cleveland.
Osborne & Sexton Machinery Co., Columbus.
Oxweld Acetylene Co., Chicago.

Pangborn Corporation, Hagerstown, Md.
Paxson, J. W., Co., Philadelphia.
Penton Publishing Co., Cleveland.
Pickands, Brown & Co., Chicago.
Pittsburgh Crushed Steel Co., Pittsburgh.
Portage Silica Co., Youngstown, O.
Pridmore, Henry E., Inc., Chicago.

Quigley Furnace Specialties Co., New York.

Racine Tool & Machine Co., Racine, Wis.
Railway Mechanical Engineer, Chicago.
Raymond Bros. Impact Pulverizer Co., Chicago.
Richards-Wilcox Mfg. Co., Aurora, Ill.
Rogers, Brown & Co., Cincinnati.
Roots, P. H. & F. M., Co., Connersville, Ind.

Safety Equipment Service Co., Cleveland.
Safety First Shoe Co., Providence, R. I.
Simonds Mfg. Co., Fitchburg, Mass.
Sly, W. W., Mfg. Co., Cleveland.
Smith, R. P., & Sons Co., Chicago.
Smith, Werner G., Co., Cleveland.
Spencer Turbine Co., Hartford, Conn.
Standard Equipment Co., New Haven, Conn.
Standard Sand & Machine Co., Cleveland.
Sterling Wheelbarrow Co., Milwaukee.
Stevens, Frederic B., Detroit.
Stodder, W. F., Syracuse, N. Y.
Sullivan Machinery Co., Chicago.
Superior Sand Co., Cleveland.

Transportation Engineering Corp., Chicago.
Thomas Elevator Co., Chicago.
Torchweld Equipment Co., Chicago.
Truscon Steel Co., Detroit.

United Compound Co., Buffalo.
United States Graphite Co., Saginaw, Mich.
U. S. Molding Machine Co., Cleveland.
United States Silica Co., Chicago.
U. S. Smelting Furnace Co., Belleville, Ill.

Vibrating Machinery Co., Chicago.

Wadsworth Core Machinery & Equipment Co., Akron, O.
Wallace, J. D., & Co., Chicago.
Warner & Swasey Co., Cleveland.
Wayne Oil Tank & Pump Co., Fort Wayne, Ind.
Westinghouse Electric & Mfg. Co., Pittsburgh.
Westinghouse Traction Brake Co., Pittsburgh.
White & Bro., Philadelphia.
Whiting Foundry Equipment Co., Harvey, Ill.
Whitman & Barnes Mfg. Co., Akron, O.
Woodison, E. J., Co., Detroit.
Wood's, T. B., Sons Co., Chambersburg, Pa.

Young Bros. Co., Detroit.

Comparing Costs of Steel Making

Statement of Cost Covering the Operation During Four Months of a 20-Ton Acid Open-Hearth Furnace and a 6-Ton Basic Electric Furnace Are Compared and Discussed

BY E. H. BALLARD

THE advance made during the past few years in practically all branches of manufacturing in no case has been more pronounced than in the steel casting industry. Prior to the war many modern foundries were built with many of the objectionable features of the old time foundries omitted, the builders having in mind only such features as spell efficiency, features that would lower the cost of production.

Electric steel-melting furnaces were installed in a number of foundries with satisfactory results. Without the electric furnace it is doubtful if the steel casting industry would have been able to contribute such a variety of necessary articles needed in carrying on the war. Particularly is this true in the case of gun castings, truck wheels and parts, ship castings, anchor chains, etc., all of which presented many difficulties which were only overcome by the persistent efforts of the foundrymen called upon to produce them.

The increase in the number of electric furnace installations in 1917 and 1918 and the report of their successful operation caused the authorities in charge of the Lynn works of the General Electric Co., to make a thorough investigation into their possibilities. A 5-ton electric furnace has been operated successfully for a number of years at the Schenectady plant of the same company and it may appear strange that Lynn foundrymen have been so backward in not making the investigation earlier. The reason is that the acid open-hearth furnaces at the Lynn plant have been able for the past 26 years to produce practically all classes of castings required, varying in weight from one pound to 30 tons and successfully meeting all physical and chemical specifications.

To maintain production from the open-hearth furnaces at reasonable cost, and to keep pace with the labor shortage, the entire open-hearth department has been rearranged. Many changes have been made including the installation of traveling cranes with lifting magnets and a mechanically operated charging machine. Economical methods

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Paper presented before the American Foundrymen's association Philadelphia convention. The author, E. H. Ballard, is connected with the General Electric Co., at the West Lynn works, West Lynn, Mass.

Comparison of Costs of Electric and Open-Hearth Steel

ELECTRIC FURNACE

Per cent	Metal charged	Price	Per	Cost per N. T.
1.00	Pig iron	$ 51.00	G. T.	$0.46
1.00		51.00	G. T.	0.46
	Scrap			
20.13	Foundry accumulations	18.00	G. T.	3.50
1.64	Castings from scrap department	18.00	G. T.	
15.63	Scrap 0.06 unguaranteed	21.25	G. T.	2.97
0.49	Nickel Turnings	21.50	G. T.	0.09
58.71	Steel turnings	8.50	G. T.	4.45
0.55	Nickel accumulations	21.50	G. T.	0.11
0.60	Iron borings	12.00	G. T.	0.06
97.75		12.80		11.18
	Special metals			
0.54	Ferrosilicon	155.00	G. T.	0.74
0.37	Ferromanganese	225.00	G. T.	0.74
0.09	Wash metal	71.20	G. T.	0.06
0.07	Aluminum titanium	166.90	G. T.	0.12
0.04	Nickel	0.50	Lb.	0.38
0.06	Copper	20.16	100 lbs.	0.23
0.08	Iron ore	9.16	G. T.	0.01
1.25		204.38	G. T.	2.28
100.00	Total metal charged	15.59	G. T.	13.92
	Molten metal cost			
	Cost of metals			13.92
	Direct labor			2.00
	Items of expense—(per detail below)			21.58
100.00	Total cost of melt			37.50
8.00	Shrinkage			
92.00	Cost of metal in ladle			40.52
30.90	Credit—Scrap produced	16.16	N. T.	
61.10	Good castings produced			53.06
	Summary of expense			
	Electrodes (30 lbs. per net ton melt)	0.08	Lb.	2.52
	Current	0.0125	KW.	9.05
	Oil-ladle	0.079	Gal.	0.26
	Water			0.24
	Slagging material—(Lime, Fluor spar, syndolag, carbon, coke)			1.79
	Furnace bottom sand	4.47	N. T.	0.01
	Ladle repairs			0.43
	Furnace repairs			1.27
	Royalty (average per net ton output) $0.446			0.27
	Depreciation 10 per cent			1.14
	Expense—Labor			1.30
	Expense—All other			3.30
	Total melting expense			21.58

Heats poured, 131.
Average weight per heat, 13,918 pounds.
Metal melted per 100 kilowatts, 275 pounds.
Kilowatt-hours per net ton melted, 720 kilowatts.

OPEN-HEARTH FURNACE

Per cent	Metal charged	Price	Per	Cost per N. T.
10.82	Pig iron Delaware	$ 51.00	G. T.	$3.45
	Robersonia	50.00	G. T.	1.45
10.82		50.70	G. T.	4.90
	Scrap			
40.40	Foundry accumulations	18.00	G. T.	
0.87	Foundry scrap castings	18.00	G. T.	8.05
8.80	Castings from Scrap Department	18.00	G. T.	
2.45	Scrap 0.06 unguaranteed	21.25	G. T.	0.46
18.08	Scrap 0.04 guaranteeed	24.78	G. T.	4.00
16.40	Bundled sheet	12.05	G. T.	1.77
87.00		18.37	G. T.	14.28
	Special metals			
0.52	Ferrosilicon	155.00	G. T.	0.68
1.29	Ferromanganese	225.00	G. T.	2.60
0.01	Wash metal	71.20	G. T.	0.01
0.11	Aluminum titanium	166.90	G. T.	0.18
	Silico Manganese	270.00	G. T.	0.01
	Aluminum	0.175	Lb.	
0.21	Iron ore	9.16	G. T.	0.02
0.04	Spiegeleisen	60.00	G. T.	0.02
2.18		180.91	G. T.	3.52
100.00	Total metal charged	25.42	G. T.	22.70
	Molten metal cost			
	Cost of metals			22.70
	Direct labor			0.83
	Items of expense (per detail below)			9.95
100.00	Total cost of melt			33.48
8.00	Shrinkage			
92.00	Cost of metal in ladle			36.38
35.66	Credit—Scrap produced	16.05	N. T.	16.05
	Summary of expense			
56.34	Good casting produced			49.24
	Fuel oil—O. H. fur., gallons	0.079		3.65
	Furnace bottom sand	4.47	N. T.	0.25
	Ladle repairs			0.22
	Furnace repairs (actual—labor and material)			0.77
	Depreciation (10 per cent on original cost)			0.98
	Expense labor			1.46
	Expense, all other			2.62
	Total melting expense			9.95

Heats poured, 162.
Average weight per heat, 37,358 pounds.
Metal melted per 100 gallons oil, 4500 pounds.
Fuel oil per net ton melted, 44.4.

of using fuel oil have been introduced and as a result it has been possible under favorable circumstances to melt steel at a cost of 37 gallons of oil per ton. These factors have made it possible to deliver molten metal in the ladle cheaper than it could have been done by the electric process.

With radical changes in the design of much of the product, the engineering department began calling for work difficult if not impossible to make by the open-hearth process. The proposition was particularly difficult when only a small quantity of alloy or special carbon steel was required. Producing small heats in an open-hearth furnace is an expensive process, and it is not good business policy to make a full sized heat requiring special mixtures, using only a small portion for the particular work desired, and pouring the remainder into regular commercial work.

From the investigation of the electric furnace process it seemed that it would meet the requirement. A 6-ton basic lined heroult-type furnace was completed and installed in the latter part of 1918. Regular production was commenced in December, 1918, with an entirely inexperienced organization. The furnace was operated for four months, day shift only, enabling us to secure actual cost data.

The writer believes that the costs of the electric furnace are comparable with those of the open-hearth when it is considered that the product is superior and is fully meeting chemical and physical requirements. It will be noted that in analyzing costs the current consumption per net ton in the ladle is 720 kilowatts. This apparent high consumption is due to the fact that 60 per cent of all heats are double slagged. A conservative estimate for single slag heats, operating according to our practice, is 650 kilowatts. The power charge of $1 per 100 kilowatt is abnormally high. A material saving in labor costs could be effected by employing a mechanical charging device which would reduce the charging time.

During the four-month period, used as a basis for cost comparison, both the electric and open-hearth furnaces were operating on short time, due to lack of business. Also it should be remembered that figures of a 6-ton basic electric furnace are compared with a 20-ton open-hearth acid furnace. There are a number of items entering into the cost of both processes which would be somewhat modified providing both were run at full capacity. It is indeed uncertain and unreliable to make up figures in any other way than on the basis of actual running cost. The figures are presented on this basis in hopes they will serve for comparison and be of material benefit to foundrymen.

In analyzing costs, the metal charge of $11.18 per net ton for the electric furnace should be noted. Substituting steel turnings at $8.50, gross ton, in place of 0.06 scrap which was used, would reduce the metal charge by $1.66 per net ton of melt. This mixture is practical and would have been used in our case if turnings had been available at the time.

Analyzing Comparative Costs

The cost of special metals for the electric furnace was $2.28 per net ton. For actual comparison we should eliminate the charge for nickel and copper, replacing 1749 pounds with ordinary scrap. This would reduce the special metal charge 49 cents per net ton.

In analyzing the expense items of the electric furnace, a current charge of $1 instead of $1.25 per 100 kilowatts should be assumed. This item would be reduced $1.80 per net ton of melt. The fuel oil charge for the open hearth is $7.90 per 100 gallons. A conservative price for oil would be $5 per 100 gallons. The fuel oil consumption, as shown in cost, is 44.4 gallons per net ton of melt. This is high due to furnace operating on short time. If a consumption of 37 gallons per net ton of melt at 5 cents per gallon is assumed, the fuel oil cost per net ton of melt would be reduced $1.85.

With the open-hearth furnace operating full time a number of cost items would be materially reduced, as follows:

Direct labor	$0.24 per net ton
Expense labor	0.50 per net ton
General expense	0.75 per net ton
Depreciation	0.25 per net ton
Repairs	0.24 per net ton
Total	$1.98 per net ton

Without going into detail as to the low fuel oil consumption per net ton of melt in the open-hearth furnace, the writer would be pleased to give such information as has been gained in the investigation which has allowed us to reduce consumption to this figure. In passing, it should be stated that these figures are not estimates but are actual tank measurements, checked by accurate oil meters, and include the heating of ladle, and week end heating of furnace.

The writer believes that foundrymen will agree that the exceptions above noted are not in the least exaggerated. They are shown in order to present the best comparison the figures will permit, assuming both furnaces are operating under normal and reasonably full time conditions. With the reductions, as above noted, a summary of costs is as follows:

	Electric furnace Net ton	Open hearth Net ton
Pig iron	$0.46	$ 4.90
Special metals	1.79	3.52
Steel turnings, scrap, etc.	9.52	14.28
Expense items	19.78	6.36
Direct labor	2.00	.59
Total cost of metals	$38.55	$29.65
Cost in ladle (8 per cent loss)	36.57	32.55

After seven months' observation of both processes we have decided that for special purposes the electric process is superior to the open-hearth and consider the additional cost not prohibitive.

The following are some of the reasons on which this opinion is based:

Freedom from serious checks in castings, due to absence of oxides, and the lower phosphorus and sulphur content.

High temperature easily attained, adapting it for light section casting.

Carbon and alloy ingots up to 13½ inches show marked superiority over ordinary open-hearth product, due to more complete deoxidation of the steel, producing a sounder ingot with less pipe and freedom from segregation, with superior forging and heat-treating qualities.

Possibility of taking small portions of heat, producing different compositions from the same heat.

Permits of intermittent running with less damage to furnace than to the open hearth.

Flexibility of working in conjunction with open hearth, permitting the casting of pieces beyond the capacity of one furnace.

Low cost of furnace charge, practice permitting a charge of 75 per cent steel turnings with 25 per cent foundry scrap, an advantageous low-priced mixture.

Low cost of producing a high grade steel for both castings and ingots.

Scrap produced by electric furnace used in open hearth as 0.04 per cent material, improving finished product of open hearth at a saving in price of 0.04 per cent material.

Wants Equipment For New Foundry

In order to finance the erection of plant additions, the Lavelle Foundry Co., Anderson, Ind., recently increased its capital. Work has started on the erection of a small foundry at Argos, Ind., and the company has in mind the erection of another plant in Indiana. The company is in the market for the necessary foundry equipment for the plants.

In the electric smelting of manganese ores in California there are at Heroult two 3-phase Noble furnaces which reduce 400 tons of ore per month. It has an average manganese content of 45 per cent and a silicon content of 15 per cent. The product contains 70 per cent of manganese.

Checking Brinell Testing Machines

Periodic Calibration of Hardness Machines Is Recommended—Simple Arrangement of Weights Acting Through a Lever of Known Ratio is Used

BY J. L. JONES AND C. H. MARSHALL

WHILE making a series of brinell tests which required a greater degree of accuracy than usual, it was found in the physical testing laboratory of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., that results obtained by two different machines did not agree. Although the loads recorded by the gages were identical, the diameters of the impressions were not the same. Naturally the gages were thought to be incorrect ;but even after the gages had been carefully standardized, the different machines gave results which did not agree. The need of a convenient means of checking these machines directly was felt and the simple lever balance was built and found to answer the purpose.

This balance consists of a single beam and a support. They are made of forged steel, machined for lightness and finish, with hardened steel knife edges and bearings. The knife edges are so placed that a multiplying ratio of practically 25 to 1 is obtained. This ratio, as checked by placing the beam in a 5000-pound Riehle testing machine, was found to be 25.02 to 1. The beam alone was found to exert an upward pressure of 322.3 kilograms. A hanger and several lead disks of convenient size were made and carefully weighed. By applying these weights, it is possible to obtain various pressures up to a maximum of 3000 kilograms.

In calibrating a machine, the adjusting screw is removed and replaced by the support, which carries a hardened steel bearing for the knife edge of the beam. The brinell ball is removed and a block carrying a knife edge inserted in its place.

The calibration of an Aktiebolaget Alpha brinell machine gave results shown graphically in Fig. 1. The gage readings are plotted as ordinates for one curve and the load produced by the controlling weights for the other. The actual load as applied by the beam is plotted as abscissae for both curves. As the controlling weights of this type of machine determine the pressure on the brinell ball, their weight should be increased or decreased so that they just balance at the proper load when applied by the beam. The gage should also be calibrated to give the correct reading under the same governing conditions.

The calibration of the improved American model brinell machine is somewhat easier, as no controlling weights are used; it only is necessary to adjust the gages to give the correct reading of load applied by the beam. The results obtained on one of these machines are given in Fig. 2. The curve marked *A* was made with the piston in the highest working position, while that marked *B* is for a lower working position. The position of the piston for the *A* curve is the same as it would be in testing hard material, where a shallow impression is made, while the position for the *B* curve is the same as it would be in testing soft materials, where a deep impression is made. The values of *A* are seen to be lower than those of *B*. This is probably because the distance between the rubber diaphragm and the top of the piston is increased when the piston is at a lower point. The tendency of the rubber to curve at the edges is then greater. The working area of the piston would therefore be less, which would require a higher gage pressure to produce the same load on the brinell ball. However, the error introduced by this is so small that it is ordinarily negligible

Abstract from a paper presented at the June meeting of the American Society for Testing Materials.

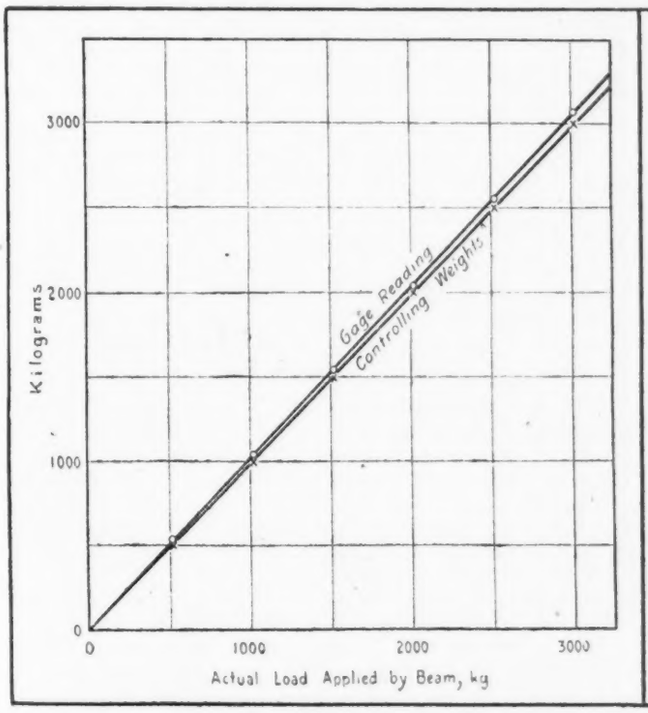

FIG. 1—CORRECTION CURVE FOR AKTIEBOLAGET ALPHA MACHINE

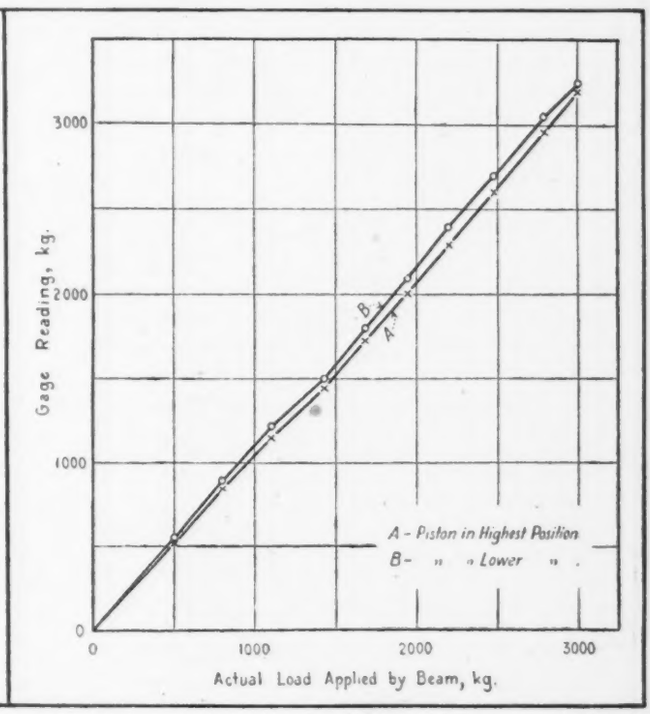

FIG. 2—CORRECTION CURVE FOR AMERICAN MODEL BRINELL TESTING MACHINE

How a Gap-Press Frame Was Molded

Details of Molding Practice on One of These Jobs—Preparing the Bed —Leveling and Adjusting the Pattern—Setting the Cores— Assembling and Closing the Mold

BY M. H. POTTER

THE gap-press frame discussed in this article was molded in a pit which was dug about one foot deeper than the depth of the pattern. A cinder bed, about 4 inches thick, was made and pipes were provided for carrying the gases away from the bottom of the mold when it was poured. The plank, A, Fig. 1, was placed as shown and was used for holding the chaplets supporting the core. Molding sand then was rammed over the cinder bed, to conform as nearly as possible to the under side of the pattern. The pattern was then forced into place, having been blocked and wedged into proper position; it was held in place by weights during the process of ramming the sand underneath.

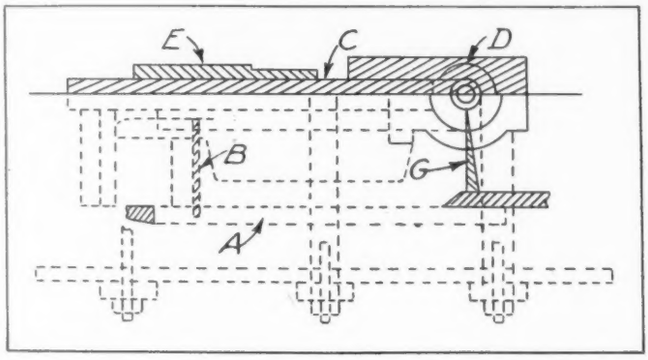

FIG. 1—PART OF THE PRESS MOLD BEDDED IN THE FLOOR

The pattern was parted at *A*, Fig. 2, and that part of the pattern below the parting was bedded in the pit, as shown in Fig. 1. The coreprint for the main core is indicated by *B*, Fig. 2. A flat iron plate was placed under this print to support the weight of the heavy main core. As the face of the feet must be fairly true and also carry a heavy strain a slab core was set to bear against it. When the sand had been rammed underneath the pattern the stakes, shown at *A*, Fig. 3, were driven and the pattern was lifted.

The bottom of the mold was well vented, the vents having extended into the bed of cinders. The bottom of the mold was made as smooth as possible before the pattern was reset and rapped down. The stakes, *A*, Fig 3, then were removed, facing sand was laid against the pattern and heap sand was rammed solidly around it, struck off and the joint was made. Parting sand was dusted on the joint, and the cope half of the pattern was placed on the drag. The cope, Fig. 4, was lowered over the pattern and held in place with stakes, *A*, Fig. 4, after which it was lifted and wet down or clay-washed. The pattern was then covered with facing sand. A slab core was placed against the foot, which was provided with a staple to permit of wiring it to the cope. Gates, risers and long stem gaggers were set in position. The pattern then was covered with facing sand and heap sand was hand-rammed to a depth of about 2 inches. Heap sand was added and several rammings performed until the top of the foot on the pattern was reached. As this is the highest part of the mold riser was placed on top of this foot. After placing the riser, sand was shoveled into the flask and rammed until the cope was filled. The cope was well vented and the core at the foot was secured. Gate sticks and risers were next removed and the cope lifted off. The pattern was drawn, the cope was finished and was coated with graphite.

Before drawing the drag part of the

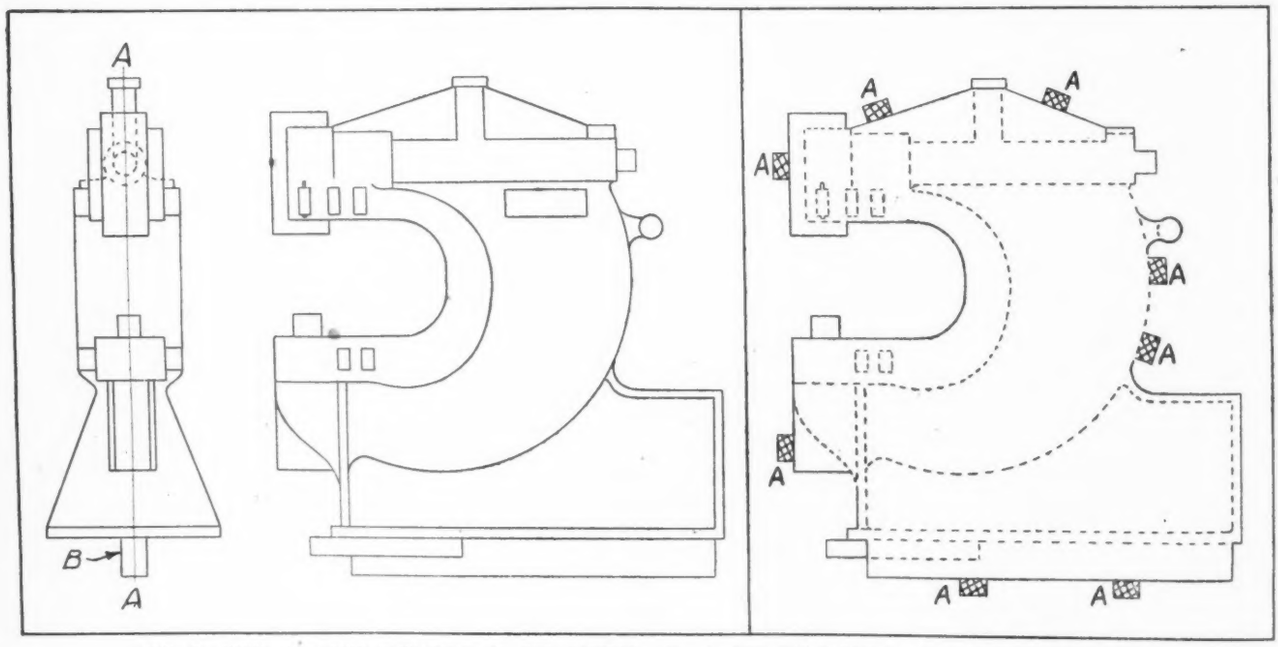

FIG. 2—FRONT AND SIDE ELEVATIONS OF THE PATTERN FIG. 3—HOW THE PATTERN WAS STAKED IN THE FLOOR

pattern the screws holding it to the base were removed. In the corner formed by the foot of the bracket, iron rods, ½-inch in diameter, were driven to support the sand. The foot portion of the pattern then was drawn and the mold finished.

Large-headed nails were pushed into the face of the mold around the jaw and the edges of the base. This prevented the heavier parts of the casting from scabbing. It was found advisable to replace the heavy graphite coating on the parts of the mold forming thin portions of the casting with a thin coat. The drag was gated and nails were forced down into the sand in front of the gates.

As a *blind* core print was used, it was held in place by chaplets. These were driven through the sand in the

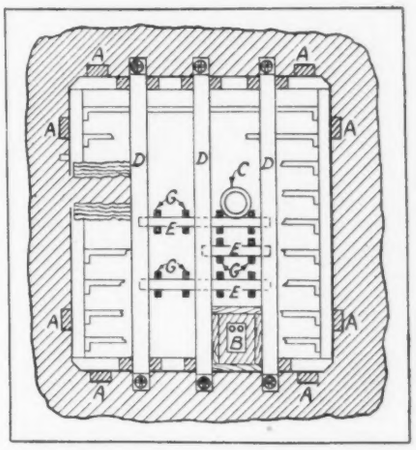

FIG. 4—TOP VIEW OF THE MOLD SHOWING BINDERS, GATE AND RISERS

pit, into the plank, *A*, Fig. 1, and extended above the face of the mold the thickness of the casting as shown at *B*, Fig. 1. The main core, *C*, Fig. 1, was then set, with one end in the core print and the other was supported by chaplets. Cores *D* and *E*, Fig. 1, were set next, followed by the shaft core, one end of which rested in the core *D*, while the other was held by a chaplet, *G*, in the coreprint.

The runner, *B*, Fig. 4, consisted of an iron ring placed around the riser, *C*. Two pieces of pig iron were placed on each side of the gate stick and formed the flow-off, *D*, Fig. 4. The cope was tried on the drag and was immediately removed and repaired where necessary. It is advisable to place white sand on such parts as may be doubtful of bearing properly. When the cope has been made to bear on the joints and cores as desired, a vent wire is run up through the cope and the chaplets are set at the indicated points. The stems of the chaplets should be long enough, so that when they are pushed up through the holes in the cope made with the vent wire, they will extend about ¼-inch above the top of the cope and still leave in the mold a length of chaplet equal to the thickness of the casting. The chaplets are held in place by soft clay squeezed around the top of the stem projecting through the cope. Paste is placed on the edges of the cores so that the iron cannot *fin* over them and enter the vents, thereby preventing the escape of gases.

The cope is closed over and the riser, *C*, Fig. 4, is covered. Binders, *D*, Fig. 4, are placed on top of the cope, blocks of iron being set between these binders and the edge of the cope. The binders are held down by hook bolts that engage eyebolts in the floor. To keep the main core from rising when the metal is poured into the mold, the binders, *E*, Fig. 4, are passed beneath the binders *D*, and are held by wedges. Wedges, *G*, are pushed in between these binders and the tops of the chaplets. The mold then is ready for pouring.

Compiles Census of Iron Foundries in Britain

An interesting census of the number of iron foundries in Great Britain has recently been completed. It was compiled, it is understood, by the board of trade with the co-operation of the British Gray and Malleable Cast Iron Research association, Birmingham. These figures show that there are 2796 iron foundries in Great Britain, of which 2439 are in England, 305 in Scotland and 52 in Ireland. The particulars according to districts are given in the accompanying table. This census also has revealed the fact that the city of Birmingham has more foundries than any other town in Great Britain. There are 118 iron foundries in the Birmingham area. Yorkshire, with 408 iron foundries, is the most important English county from a foundry standpoint. According to figures compiled from the same source, it is estimated that the output of malleable cast iron in Great Britain in 1913 was 75,000 tons; durin the same year the output of gray-iron castings is estimated to have been 3,000,000 tons. It is not believed that these figures have been very largely increased since the war, inasmuch as the war did not call for extenisve expansion of gray-iron or malleable casting facilities.

Number of Foundries in Great Britain

ENGLAND		
NORTHERN COUNTIES	Northumberland, Cumberland, Durham, Westmoreland, Lancashire, Yorkshire	881
MIDLAND COUNTIES	Staffordshire, Worcestershire, Warwickshire, Leicester, Derbyshire, Nottinghamshire, Northants	828
WESTERN COUNTIES	Wales, Chester, Salop, Hereford, Monmouth, Gloucester, Somerset, Devonshire, Cornwall	321
EASTERN COUNTIES	Lincolnshire, Norfolk, Cambridgeshire, Huntingdonshire, Suffolk, Essex, Bedfordshire, Buckinghamshire, Hertfordshire	174
SOUTHERN COUNTIES	Berkshire, Wiltshire, Dorset, Hants, Sussex, Surrey, Kent, Middlesex, Oxford	137
LONDON		98
		2439
SCOTLAND		305
IRELAND		52
	Total	2796

Homer Furnace Co. Starts Foundry School

A school for the education of workmen in foundry practice and metallurgy, known as the Coldwater School of Foundry Technology, was started recently by the Homer Furnace Co., Coldwater, Mich. This new feature is the idea of H. D. Keller, superintendent, who desires to educate the employes of the company to become more proficient and to fill many positions where executive ability is necessary. The course of instruction was prepared by David McLain, McLain's System, Milwaukee. It consists of 12 lessons, each lesson to cover a period of about two months. Besides the lessons from the McClain school Mr. Keller, will give instruction in the plant During the course weekly lectures will be given by Messrs. McLain and Keller, and others will be called to lecture on special subjects on which they are known to be proficient.

Teetor Co. Incorporated

The R. J. Teetor Co., Muskegon, Mich., recently incorporated with a $300,000 capital stock, will manufacture under contract molding machines, etc. The company now is having its products manufactured under contract, and plans ultimately to equip a plant and do its own manufacturing. Officers are: President, R. J. Teetor; vice president, E. L. Howe, and secretary-treasurer, Andrew Wierengo. The office of the firm is at 309 Union Bank building, Muskegon.

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Specialist Should Rig Patterns

THERE are many slants to making castings and the omission of one essential may hinder seriously the success of the entire cycle of operations. To secure good castings, the metal must be of a certain composition and the molds must be correctly gated and made of the proper grade of sand. Further, to secure economical production, patterns must be rigged in the most efficient manner. Not every foundryman is qualified to do this, therefore the final decision on rigging should devolve upon someone who has proved his ability. No matter how brilliant nor accomplished no one can rig patterns so that no improvement is possible. Therefore, every assistance should be available to the one responsible for this work. After the rigger has decided on the method he thinks best for molding the casting, the foreman on the floor on which the casting is made should be called in to discuss the rigging. He is closer to the operating end than the one who has designed the rigging and through his personal experience may have pertinent suggestions of value. At this time the foreman will have opportunity to criticize, and if he has no suggestions, it is taken that he concurs in the judgment of the designer. He then has no excuse for not producing the rated number of castings. At the conference between the foreman and the designer of the rigging, the proper grade of workman to put on the job also may be decided. Possibly the foreman has no molder to put on the job, then alterations must be made to enable a laborer to make the mold, or other points may be shown by the foreman which make the method of rigging impractical as designed. This form of organization, in operation in many foundries, utilizes the ability of the highly trained expert and modifies it with the practical experience of the molding foreman.

Malleable Shops Increase Capacity

READJUSTMENT after the war has brought about a marked demand for malleable castings. This has been so pronounced that the malleable shops in operation at capacity immediately after the armistice were unable to handle the great volume of work which came to them and there was a decided increase in the number of new plants erected. Previous to 1919 there had been relatively little new construction in the malleable field, and the gain in capacity of the malleable iron shops was comparatively small from year to year. However, within the past 18 months there has been built, or started, enough new construction to increase the capacity of the malleable-iron foundries in the country by from 25 to 33 1/3 per cent. Some of this new development was started by manufacturing plants which found it almost impossible to secure the necessary castings, while a large proportion of it was furnished by established foundry companies which increased their plants or built new ones. Most of the increased business which came to malleable foundries was due to the greatly augmented demand for automobile castings. The capacity is now becoming large enough to handle this work promptly but a revival in the demand for railroad castings is expected to again overtax malleable foundries. However, the slacking of demand for automobile castings which is at present in evidence will allow the filling of quite a large demand from the railroads.

Trade Outlook in the Foundry Industry

FUTURE price trends in foundry basic raw materials are the source of much interested speculation at the present time. The railway rate advance which becomes effective this week is the strongest factor upon which a probable rise in price levels is forecasted. Opposing this tendency is the force of receding demand for manufactured materials which is evident in many lines. Slowing down in the general buying movement, which reached a peak in the early summer, may serve as an effective brake upon any radical upward movement in coke, scrap, pig iron and other commodities. Although pessimism is absent, conservatism is dictating greater care in manufacturing schedules in practically all lines.

Iron Prices in Doubt

A wide divergence in prices on pig iron produced in the different districts is expected to result when the new freight rates are in effect. The balance will be slightly in favor of those furnaces which are located along the Great Lakes where ore may be delivered without an added cost of rail transportation and where coke and limestone are close at hand. It is stated that eastern furnaces will face an increase of about $2.50 a ton on raw materials, while in the Youngstown district the increase will be about $1.50 to $1.60 a ton. Southern furnaces will be at a marked disadvantage in the transportation of their finished product to many foundry centers. The gains made by southern ironmakers during the war and the period following probably will be decreased, particularly if the demand for castings falls off during the next few months. No slackening in demand for southern iron has been apparent up to the present time, the inquiry for first quarter 1921 delivery having been in excess of the tonnages which makers are willing to contract at present prices. Diffidence has been shown by producers and consumers alike in contracting iron for the coming year, pending the effects of the various factors now being brought to bear on prices.

Prices of Raw Materials for Foundry Use

CORRECTED TO AUG. 24

Iron		Scrap	
No. 2 foundry, valley	$47.00 to 50.00	Heavy melting steel, Valley	$27.50 to 27.75
No. 2 Southern, Birmingham	42.00 to 45.00	Heavy melting steel, Pittsburgh	29.00 to 29.50
No. 2 Foundry, Chicago	48.00 to 50.00	Heavy melting steel, Chicago	25.50 to 26.00
No. 2 Foundry, Philadelphia	50.90 to 52.05	Stove plate, Chicago	32.00 to 32.50
Basic, Valley	48.50	No. 1 cast, Chicago	42.00 to 42.50
Malleable, Chicago	46.50	No. 1 cast, Philadelphia	39.00 to 41.00
Malleable, Buffalo	51.25	No. 1 cast, Birmingham	33.00 to 35.00
Coke		Car wheels, iron, Pittsburgh	45.00 to 46.00
Connellsville foundry coke	$18.00 to 19.00	Car wheels, iron, Chicago	39.00 to 39.50
Wise county foundry coke	18.50 to 20.00	Railroad malleable, Chicago	32.50 to 33.00
		Agricultural malleable, Chicago	33.00 to 33.50

No Recession in Castings

No immediate decline in castings prices is to be expected from present indications. It is evident that all those materials which enter into castings manufacture will show no immediate fall in price. Further, the freight increase undoubtedly will exert a strong influence. While labor is slightly more plentiful, and a greater efficiency is reported, the past quarter, according to accurate comparative figures has developed a still greater advance in the labor factor entering into finished casting costs. In one branch of the foundry industry, the second quarter of the present year has been marked by an increase of about 15 per cent in the labor cost on each ton of castings, as compared with the third quarter of 1919. Labor in this instance represents about 40 to 60 per cent of the entire cost of production. Fuel prices, although not so important in computing the price of foundry products, likely will become a source of greater concern as the winter advances. Steel foundries melting in electric furnaces report an advance in power delivery charges throughout the country where utility corporations are obliged to meet higher prices on fuel.

Demand Is Weaker

Although gray iron and malleable shops in general continue to have ample orders, but little new inquiry is evident. Starting with the automotive industries, where retrenchment has been the rule for the past month or six weeks, a slackening of demand is noted. Although there has been only a few actual cancellations, the volume of new inquiry has fallen off to a degree that has permitted car manufacturers to place orders for new business readily, while during the early summer it was almost impossible to secure shop facilities for furnishing many cast parts which enter into automobile and truck manufacture. Malleable and gray iron shops alike which make castings for the automotive industries still have sufficient business to maintain full operation, and although new inquiries are practically absent, and deferred deliveries are requested in some instances, these foundries are making no effort to solicit business from other than the automotive industries. Prices paid for automobile castings are attractive, the equipment and facilities of these shops are best adapted to this class of work and almost without exception, they are optimistic in predicting an early return of heavy requirements from the automobile builders. Malleable and steel foundries which are engaged on railroad work have all that they can do in meeting the demand for repair and replacement parts. The call for castings from the railroads is so strong that some shops are endeavoring to sublet contracts in excess of their facilities. Little new car business is offered. Whether this is from a canny desire to prevent bulling the market or whether the improvement in transportation may serve to cut down the estimated requirements for new equipment is not apparent at this time. Agricultural implement makers sufficient orders to last through several months, and those making castings for building construction have noted a slight increase in inquiries. Prices of nonferrous metals based on New York quotations of Aug. 25 follow: Copper, 18.00c to 18.12½c; lead, 9.25c to 9.32½c; Straits tin, 45.50c; antimony, 7.00c to 7.25c; aluminum No. 12 alloy, producers' price, 34.00c and open market, 29.00c. Zinc is quoted at 8.05c to 8.40c, East St. Louis.

Comings and Goings of Foundrymen

JAMES A. MURPHY, who recently resigned the position of foundry superintendent of the Hooven-Owens-Rentschler Co., Hamilton, O., has been made president and general manager of the Connersville Foundry Co., Connersville, Ind. Mr. Murphy is widely known throughout the foundry industry. During the past 20 years he has had charge successively of the Ball Engine Co., Erie, Pa.; the Chicago Pneumatic Tool Co., Franklin, Pa.; and the Interstate Foundry Co., Cleveland. For the past 13½ years he has been superintendent of the Hooven-Owens-Rentschler foundry in Hamilton, O. Always a close student of foundry problems and of pioneering disposition, he introduced many innovations in the casting industry which today are regarded as standard practice. Stringless wax vents for venting thin and difficult cores, skimming and spraying devices, ingenious flask construction and rigging for casting large work, particularly large fly wheels, molded above the floor, furnish examples of his varied accomplishments. His phenomenal record in turning out the castings for over three hundred 2800-horsepower engines for the Emergency Fleet corporation at the rate of 10 complete engines a week, probably will be unexcelled for some time to come. In addition to his foundry activities, Mr. Murphy always has taken an exceedingly active part in the community life of the city. During the war he organized and captained a full company of home guards.

W. R. Clark has been appointed superintendent of the Automotive Castings Co., Imlay City, Mich.

L. W. Hewitt has been appointed general manager of the Specialty Brass Co., Kenocha, Wis.

B. T. Bacon retired recently after serving Pickands, Brown & Co., Chicago, pig iron dealers, as sales agent for 36 years.

H. D. Balsinger, has resigned as a superintendent in the American Steel Foundries to accept the assistant superintendency of the T. H. Symington Co., of Rochester, N. Y.

R. L. Favor has resigned as foundry foreman, Charleston navy yards to accept a similar position with the Emery Steel Castings Co., Baltimore.

J. F. Hunter, who has been acting general sales agent of the Virginia Iron, Coal & Coke Co., Roanoke, Va., has been appointed general sales agent, effective Aug. 1.

Arthur Corbeille has been appointed manager of the W. L. McCullough Foundry Co., Ypsilanti, Mich.

Fred A. Blackston, has been elected vice president and treasurer of the Eagle Iron Works, Muskegon, Mich., Mr. Blackston was formally an official of the Linderman Steel & Machine Co.

George J. Martin has been made assistant superintendent of the Aetna

JAMES A. MURPHY

Foundry & Machine Co., Warren, O., having previously been chief engineer of the same company.

Edgar M. Lewis, formerly connected with the E. J. Woodison Co., Detroit, recently has become associated with the J. S. McCormick Co., Pittsburgh, makers of foundry supplies.

W. C. Hamilton, formerly works manager of the American Steel Foundries, Granite City, Ill., has been appointed works manager of the Duquesne Steel Foundry Co., Coraopolis, Pa.

A. C. Porter has resigned the position of foundry superintendent with the Cushman Motor Works, Lincoln, Nebr., to accept a similar position with the Witte Engine Works, Kansas City, Mo. Mr. Porter is a graduate of Wentworth institute, Boston, where he made a special study of metallurgy, production efficiency, and foundry chemistry.

Fred E. Smith has resigned his connection with Philip E. Wright, Stephen Girard building, Philadelphia, to become associated with Carson & Co., Pennsylvania building, that city, dealers in pig iron, coal, coke and ferroalloys.

James A. Carey, formerly Pittsburgh resident manager for the Hill & Griffith Co., has entered business for himself and is handling a general line of foundry facings, supplies and equipment, with offices in the Fulton building, Pittsburgh.

W. J. Jones, works manager of the J. I. Case Plow Works Co., Racine, Wis., has been elected a vice president of the company in charge of production. Mr. Jones has been affiliated with the company only about one year.

Frederick A. Pelton, an assistant cashier of the Northampton National bank, Northampton, Mass., has resigned to take effect Sept. 1, when he will become assistant treasurer of the Haydenville Co., Haydenville, Mass., maker of brass and iron goods.

Robert H. Irons, president of the Central Iron & Steel Co., and Ross A. Hicok, treasurer of the W. O. Hicok Co., Harrisburg, Pa., have been named members of the representative council at the Harrisburg offices of the Pennsylvania state employment service.

K. V. Wheeler has recently resigned as superintendent of the Electric Steel Co., Chicago, to become general manager of the Lebanon Steel Foundry, Lebanon, Pa. Prior to the war Mr. Wheeler was with the Dominion Steel Foundry Co., Hamilton, Ont., Can., and from there went to the Zimmerman Steel Co., Bettendorf, Iowa, where he for some time served in the capacity as superintendent.

Plan National Engineering Society

The joint conference committee of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers has sent invitations to approximately 150 leading engineering societies in the United States, asking them to appoint

delegates to a meeting to be held next fall for the purpose of forming a national engineering organization. The proposed organization will be known as the Federated American Engineering societies and will have a prospective membership of 225,000 in all lines of engineering. The executive body will be known as the American Engineering council, representation in which will be granted to the component organization. While details have not been definitely decided, it is expected the council will be ready to succeed the existing engineering council, organized for war work in June, 1917, when the original council goes out of existence.

Will Study Material Handling Methods

The American Society of Mechanical Engineers, has formed a materials handling section whose object is to "promote the art of the mechanical handling of all materials."

The first meeting of this section was held at the Engineering Societies building, 29 West Thirty-ninth street, New York, Aug. 13. Robert M. Gates, managing engineer specializing in material handling equipment, Lakewood Engineering Co., Cleveland, presided. In his address Mr. Gates emphasized the fact that the section must be a bureau of information—complete in its scope, specific in its knowledge of the physical and economic conditions, and unbiased in its conclusions.

Steel Treaters to Meet

The annual convention of the American Steel Treater's association and the Steel Treating Research society will be held in Philadelphia, Sept. 14-18. Besides the long program of technical papers dealing with all phases of heat treatment a display of heat treating equipment will be given by more than 125 exhibitors. The date of this convention will give the exhibitors ample time to ship their exhibits to Columbus, O., for the foundrymen's convention. An extensive entertainment program is being arranged for the members and guests in attendance.

Welding Society Forms Pittsburgh Section

The American Welding society organized a Pittsburgh section Thursday afternoon, Aug. 12. The officers elected were: Chairman, J. D. Conway; first vice chairman, Dr. R. H. Brownlee; second vice chairman, H. H. Maxfield; temporary secretary, F. W. Tupper, and treasurer, F. O. Gardener. The members of the executive committee are: W. M. Finlayson, G. H. Danforth, J. A. Warfel, F. C. Satterley, A. M. Candy, H. D. Kelley, D. J. Ridding, C. H. Newbury, Carles Crates, F. S. Austin, J. H. Rush and B. P. McDaniel

The first open meeting of the new section was held in the evening at the chamber of commerce auditorium. At this meeting a number of short papers were presented. W. R. Hulbert, the Metal & Thermit Corp., New York, presented a paper describing the repair of the stern frame of the army transport, NORTHERN PACIFIC, by means of thermit. This paper was illustrated with moving pictures. Douglas F. Miner, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., told of recent developments in percussion welding. Gas cutting methods were described by C. J. Nyquist, C. J. Nyquist Co., Cleveland.

CHARLES J. WILTSHIRE

J. H. Deppeler, president of the welding society, spoke of the general organization of the society and said that the Pittsburgh section was the third to be organized, sections having been formed in Philadelphia and New York. Other sections will be established in different parts of the country, Mr. Deppler said. He called attention to the work of the American Bureau of Welding which is controlled by the American Welding society in conjunction with representatives from a large number of other technical societies. This bureau is a research organization which calls on the industry directly interested in any particular line of work which it undertakes, for financial assistance. The results of the research are then given out for the benefit of those interested in welding. This branch of work is comparatively new and considerable development is anticipated in the future. So far little success has been made in cutting gray iron with a gas flame, but Mr. Nyquist stated that he thought a practical method for doing this would soon be perfected.

Charles J. Wiltshire Is Killed in Accident

Charles J. Wiltshire for the past 13 years superintendent of the iron foundry department of the Schenectady works of the General Electric Co., Schenectady, N. Y., was killed in his automobile on July 19, when it was struck by an interurban car.

Mr. Wiltshire was born in Ealing, now a part of London, England, Aug. 2, 1862, and came to the United States with his parents when about 10 years old. The family located at Chicago. His first employment was that of an errand boy for Marshall Field & Co., but later he was apprenticed as a molder and subsequently secured training in the office routine of foundry operations. He spent a short time in foundries on the Pacific coast in 1892 and subsequently was employed at Providence, R. I., and Chester, Pa., in steel and brass as well as foundry work. For a while he was in charge of the brass foundry of the National Cash Register Co., Dayton, O. About 1894, he returned to Chicago and was placed in charge of the iron foundry operated by the Gates Iron Works of that city. After several years affiliation with the Gates Iron Works, he served as foreman of the iron foundry of the Pullman Co., Pullman, Ill., and of the foundry of the Western Electric Co., Chicago. In 1907 he was appointed superintendent of the iron foundry of the General Electric Co. and had charge of the iron and steel casting production. The position he held at the time of his death. In his work with this company he was closely identified with the work of developing the electric steel casting process.

Mr. Wiltshire was a member of the American Foundrymen's association and was a member of the committee on general specifications for gray iron castings to co-operate with the American Society for Testing Materials.

John M. Glass, formerly with the Hill & Griffith Co. Cincinnati, has incorporated a company known as the John M. Glass Co., Indianapolis, Ind. Associated with him is L. A. Daly, also formerly connected with the Hill & Griffith Co.

Truck Wheels Stronger Than Necessary

Radial-compression and side-thrust tests were made on a large number of motor-truck wheels, using the Emery hydraulic testing machine at the bureau of standards. This large machine has a capacity of 2,300,000 pounds. For the radial-compression tests the wheel was placed on a short axle supported on both sides of the wheel by bearing blocks. Load was then applied through a block at the rim. This block distributed the load over the full width of the rim and along an arc of 6 inches. The wheel was placed so that the load was applied to a section of the rim between spokes.

In the side-thrust test the load was applied to the side of the rim of the wheel through a block 6 inches wide. The wheel was so placed that the point of application of load was between spokes and approximately 90 degrees from the point at which the stress had been applied in the radial-compression test. In this test the wheels were loaded to destruction.

These laboratory tests were not intended to supplant service tests, but the bureau of standards concludes that much information can be obtained in the laboratory which could not be obtained by service tests within a reasonable length of time. Defects in design and material are soon made apparent in laboratory tests and changes can be made before wheels are manufactured in large quantities.

The wheels tested were representative of those used on 3 and 5-ton trucks, and it is quite improbable that any of these wheels would ever be stressed even to its proportional limit.

The wheels tested are all stronger and heavier than is necessary, and a saving in material should be effected.

A reduction in weight is worthy of consideration, not only because of the material saved, but also because it would result in an increase in the life of tires and of roads.

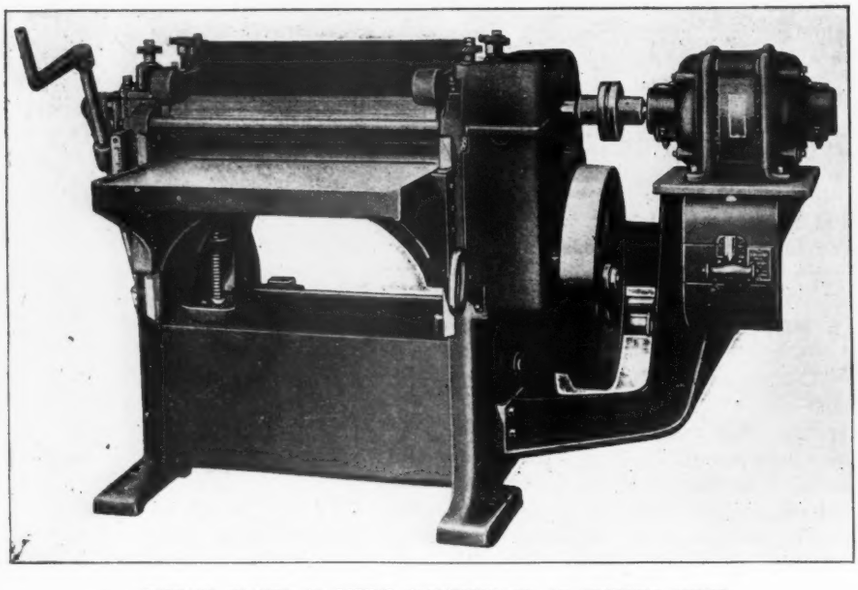
A description of the tests with curves showing all the information obtained from tests on each wheel are given in technological paper No. 150 of the bureau of standards.

Light Fixtures Cleaned Automatically

Dust in the foundry soon covers any lighting equipment and reduces its efficiency making frequent cleaning necessary to secure satisfactory results. In order to reduce lighting maintainance charges the Associated Engineers Co., Chicago, has put on the market a device which cleans the lamp and shade each time the light is turned on or off. This device, as shown in the two accompanying illustrations consists of two wiping blades; one rotates against the interior of the reflector, and one against the lamp bulb. As the stem switch is pulled, these two blades come into action, sweeping the dirt off both lamp and reflector by a complete revolution. The blades never reverse. Such frequent cleaning does not allow dirt to cake on the reflector, and the accumulation of a few hours is not sufficient to annoy workmen in dropping down on the work below. The tendency is rather for the finely divided dirt to float away.

PULLING THE CORD WHICH OPERATES THE SWITCH ALSO REVOLVES THE WIPING BLADES

WIPING BLADES CLEAN THE LAMP AND THE REFLECTOR



SURFACE PLANER IS DIRECT CONNECTED TO AN ELECTRIC MOTOR

Surfacer Changed to Motor Drive

The Oliver Machinery Co., Grand Rapids, Mich., has designed its surface planer for direct motor drive. It is driven by a standard 3600-revolutions-per-minute motor coupled to the cutting cylinder. Thus belts are no longer needed. In order to secure the proper number of cuts per minute three high-speed cutting knives are supplied in the cutting head. Having the motor drive, it is not necessary to set the planer in any special place to line up with shafting. The surfacer is self contained and so considerable saving of room is effected over the former belt-driven machine.

Outlines Carbon Case

Dealing with the strage, use and handling of carbon electrodes the National Carbon Co., New York, has recently completed a booklet intended for those interested in electric furnace operation. In the preface is a history of electric furnaces from the

time in 1878 when W. Siemens designed and built a furnace, until the present time. It explains also how the by-products calcium carbide, artificial abrasives, aluminum, ferroalloys and phosphorus have been made possible by electric furnaces. According to the booklet the electrodes should have such characteristics as low electrical resistance, low heat and high conductivity. Care should be exercised in handling electrodes especially in unloading from cars as this often causes defects detrimental to efficient operation.

Among the principles embodied in joining electrodes is the use of a "joint" compound to fill the space between and insure continuous contact. This compound should be plastic and adhesive but of such consistency that it will not melt out when the electrodes become heated. Details of connecting, taken up in the publication, include such principles as applying the compound, adjusting the connecting pin, picking up the electrodes, and screwing them together. When unwarranted oxidation occurs, under the furnace roof, it is known as *spindling* and to insure minimum electrode consumption this must be eliminated. The causes of this together with those incident to *wasping* and the most important factors in securing minimum oxidation of electrode are made clear in the booklet. Logs and records used in connection with furnace operation are advocated by the company manufacturing carbons.

Tables of data for both round and square electrodes conclude the publication. These contain information as follows: sizes, areas, current carrying capacities formulas for deducting the data and a bibliography of books and articles incident to the subject of carbon electrodes.

The McMyler Interstate Co., of Warren, pioneer in the manufacture of castings, etc., in Warren, has been sold to interests connected with the Brier Hill Steel Co. Since Aug. 1 it is known as the Eastern Ohio Steel Co. Charles Lewis, sales manager of the Sykes Metal Lath Co., of Niles, is manager of the new company.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

The Marengo Foundry & Machine Co., Marengo, Ill., has opened an addition to its plant.

A building, 60 x 75 feet, will be erected by the Hercules Steel Casting Co., Milwaukee.

The National Brake & Electric Co., Milwaukee, plans the erection of a foundry, 166 x 180 feet.

Erection of a pattern storage building is being planned by the Watson-Stillman Co., Aldene, N. J.

The Howell Foundry, Howell, Mich., plans the erection of a plant.

Erection of a foundry building, 56 x 100 feet, is planned by the Hamburg Foundry Co., Hamburg, Pa.

The Galesburg Foundry & Casting Co., Galesburg, Mich., has changed its name to the Battle Creek Jobbing Foundry Co.

Plans have been prepared by the A. Garrison Foundry Co., Ninth and Bingham streets, Pittsburgh, for the erection of a plant addition, 200 x 240 feet.

The Kokomo Malleable Iron Co., Kokomo, Ind., has increased its capital stock from $350,000 to $500,000.

The Silver Iron & Steel Co., Greenville, O., shortly will start work on the erection of a foundry, 100 x 200 feet.

The United Machine & Mfg. Co., Akron, O., has had plans prepared for the erection of a new foundry, 100 x 200 feet.

Erection of an addition to its foundry, 110 x 118 feet, is being planned by the Excelsior Machine & Tool Co., East St. Louis, Ill.

The Lake Erie Foundry Co., 218 Chicago street, Buffalo, plans the erection of a foundry, 37 x 82 feet.

Capitalized at $20,000, the Superior Castings Co., Dayton, O., has been incorporated by R. F. Shields, W. Hicks, A. W. Newman, and others.

The capital stock of the James Leffel Co., Springfield, O., recently was increased from $750,000 to $1,750,000.

The capital stock of the Chambersburg Foundry Co., Chambersburg, Pa., has been increased from $5000 to $132,000.

The capital stock of the Werner G. Smith Co., Cleveland, recently was increased from $750,000 to $1,500,000.

The Salem Foundry & Machine Corp., Roanoke, Va., is said to have under consideration, plans for the erection of a foundry and machine shop.

Capitalized at $5000, the Enterprise Brass Foundry, Inc., Boston, recently was chartered by William S. Rendle, 52 Porter street, Melrose, Mass., and others.

The plant of the Steigler & Kerr Stove & Foundry Co., 2201 Folsom street, San Francisco, recently was damaged by fire.

Work on the erection of a new plant for the Cooper Brass Works, Ogdensburg, N. Y., is rapidly nearing completion.

The Wheeling Axle Co., Wheeling, W. Va., which was recently organized, has arranged for the erection of a building to be used as a foundry.

The A. E. Martin Foundry & Machine Co., 705 Clark street, Milwaukee, plans the erection of an addition to its foundry, 30 x 145 feet.

The Detroit Motor Castings Co., Detroit, has placed an addition to its plant in operation. It is 75 x 125 feet.

Capitalized at $75,000, the New Haven Foundry Co., New Haven, Mich., recently was incorporated by F. J. McCracken and others.

Erection of an addition to its foundry, 30 x 100 feet, is planned by the Beans Foundry Co., Martins Ferry, O.

The Fox River Tractor Co., Appleton, Wis., is erecting a plant addition, 40 x 75 feet, and later will erect a machine shop and gray iron foundry.

The Traction Steel Castings Co., East La Porte, Ind., which recently purchased a site for a plant, will start work shortly on the erection of the structures.

Operations in its gray iron foundry will be started about Sept. 10 by the Newman Foundry, Kendallville, Ind. It will turn out light and medium jobbing work.

The Charles H. Milles Foundry Co., Chicago, has bought a site on which it plans the erection of a foundry, 100 x 200 feet. It is said the company's present plant will be sold.

Capitalized at $100,000 the Palmyra Foundry Co., Palmyra, N. J., recently was incorporated by G. C. S. Welzel, L. F. Thum and John T. Mercer, to manufacture iron and steel castings, etc.

It is reported the Ware Foundry Co., Ware, Mass., is planning to increase its capital stock to $50,000, part of the increase to be used in financing expansion.

Capitalized at $50,000, the Sward Foundry & Machine Co., recently was incorporated with headquarters at Youngstown, O., by J. Adams, G. Winkelholz, T. Donofrio, W. T. Richards and J. Salata.

Plans have been completed by the Union Mfg. Co., New Britain, Conn., for the erection of a building, 49 x 51 feet. The company manufactures gray iron castings, etc.

The Simple Gas Engine Works, Menasha, Wis., has tentative plans for the erection of an addition to its foundry and core room, to be 60 x 100 feet. F. J. Oberweiser is president and general manager.

The capital stock of the Roberts Brass Co., 178 Lincoln avenue, Milwaukee, manufacturer of brass castings and small brass specialties, recently was increased from $15,000 to $50,000.

Erection of a new plant, 40 x 125 feet, is being planned by the Shreveport Brass Works, Shreveport, La. It is proposed to install a large amount of new equipment. R. J. Morton is manager.

The Princeton Foundry & Supply Co., Princeton, W. Va., has been incorporated with a capital stock of $50,000, by L. E. White, G. H. Crumpecker and C. W. Hall.

The Central Malleable Castings Co., Franklin Park, Ill., has bought the plant of the Northwestern Steel Corp. and will equip and use it as a malleable gray iron foundry. Charles Drozeski is president.

The Rochester Casting Corp., Rochester, N. Y., has been incorporated to carry on business with an active capital stock of $1,050,000, by C. F. Wray, A. N. Wright and L. O. Graves.

Capitalized at $100,000, the Mt. Holly Foundry Co., recently was incorporated in Delaware, by Lewis R. Palmer, George C. Palmer, Ridley Park, Pa., and John F. Malloy, Wilmington, Del.

The Jorgenson Mfg. Co., Waupaca, Wis., will build a brass foundry and is having plans prepared for the erection of an addition to its hydro-electric power plant.

The Detroit Valve & Fittings Co. and the Detroit Brass Works, Detroit, which were recently merged, will be operated under the name of the Detroit Brass & Malleable Works.

Work has been started on the erection of a 1-story, 35 x 200-foot machine shop, a 50 x 100-foot foundry and a 40 x 100-foot pattern shop, for the National Woodworking Machine Co., Dover, N. H.

The Ruud Mfg. Co., Twenty-ninth and Smallman streets, Pittsburgh, is having plans prepared for the erection of a plant addition to be used as an

extension to the foundry and machine shop. Edward Ruud is president of the company.

The Jamestown Malleable Iron Products Co., Jamestown, N. Y., has had plans drawn for the erection of a foundry, 260 x 300 feet.

The Valley Falls Foundry & Machine Co., Cumberland, R. I., has been incorporated with a capital stock of $150,000, by John F. Murphy, West Warwick, R. I.; Fred A. Tobin, East Providence, R. I., and Joseph F. McSolvey.

The American Malleable Iron Corp., Lynchburg, Va., which was recently incorporated in Delaware with a capital stock of $1,000,000, has acquired a site on which it plans the immediate erection of a plant.

An aluminum and brass foundry has been established at 2157 Blue Island avenue, Chicago, under the name of the National Aluminum & Brass Foundry, by Victor S. Kucki and Frank T. Luka. Jobbing work in aluminum, brass and bronze will be done.

The Claus Automatic Gas Cock Co., Milwaukee, has announced that it shortly will erect a brass foundry to contain approximately 15,000 square feet. The company i interested in all of the latest labor saving, tumbling, melting and metal carrying devices now on the market.

Bids will be taken by the Worthington Pump & Machinery Corp. for the erection of a 4-story, pattern shop and extension to the pattern storage vault, at the company's branch plant at Cudahy, Wis., which is known as the Power & Mining Machinery Co. and the International Gas Engine Co. The building will be 60 x 180 feet.

Capitalized at $60,000 the Hall Foundry & Machine Co., Inc., Jacksonville, Tex., is conducting a general foundry and machine shop business. It possibly will later on engage in some manufacturing in the new building, which now is being erected. All machinery needs have been contracted for. Sam J. Hall is president, R. I. Weir is secretary and treasurer and F. L. Haberle is vice president.

Organized for the purpose of making malleable castings, the Ashland Malleable Co., Ashland, O., expects to have a foundry built before Jan. 1. It is capitalized at $150,000, and will be in the market for all sorts of foundry equipment. Officers of the company are: President, J. H. Firestone; vice president, Samuel Miller; treasurer, E. M. Armstrong, and secretary, W. L. Rybolt.

Two 10-ton cranes, built by the Milwaukee Crane & Mfg. Co., Milwaukee, recently were purchased by the Valley Iron Works Co., Appleton, Wis., which has equipped a foundry and manufacturing building, to be devoted to the manufacture of machinery for paper and pulp mills. The foundry is 40 x 120 feet and the manufacturing building, 42 x 140 feet. E. A. Paterson is general manager and W. H. Burns is assistant manager.

To engage in the manufacture and machining of gray iron castings, the Decatur Castings Co., Hamilton, O., recently was organized by interests connected with the Hamilton Foundry & Machine Co., Hamilton, O. It is capitalized at $400,000 and it has a plant at Decatur, Ill., which is fully equipped and now in operation. Officers of the company are: President, Gordon S. Rentschler; vice president, G. A. Rentschler; secretary and treasurer, H. A. Rentschler and general manager, D. McDaniel.

The Pioneer Brass Works, Indianapolis, is erecting a foundry building, 150 x 200 feet, which will include a molding room, furnace room, core room and grinding room. The structure will be of brick and steel construction. From 35 to 50 additional molders' benches, several large type roll-over jolt molding machines and some additional squeezers will be needed in the way of new equipment. J. H. Brinkmeyer, is president and Carl W. Piel is secretary of the company.

Construction has been completed of a plant for the Shea Bronze Casting Co., 232 Fifth street, Bridgeport, Conn., and work will start in the new building as soon as all necessary equipment has been installed. The company is now in the market for a small core oven, 12 x 18 feet, a steel or iron flask tumbling barrel, sprue cutter, three horsepower motor and grinder, and small tools and supplies. J. F. Shea is one of the officers of the company.

Contracts have been let by the Colonial Foundry Co., Louisville, O., manufacturer of semisteel castings, for the erection of an addition to its foundry. The building will be 60 x 160 feet, of structural steel construction, and will be equipped with a 15-ton electric crane, a 72-inch cupola and an electric blower. When completed castings up to 25 tons will be turned out. The Alliance Structural Steel Co. has the contract to build the structure, while the Alliance Machine Co. will furnish the crane and the J. S. McCormick Co., the cupola and blower. It is expected the structure will be ready for occupation about Dec. 1. C. A. Jackson is general manager of the company.

New Trade Publications

MELTING POTS.—The Cutler-Hammer Mfg. Co., Milwaukee, recently issued a 2-page leaflet, in which metal melting pots, both portable and bench types, are described and illustrated. These pots are said to be especially serviceable for melting lead, tin, solder, babbitt, etc., the claim being that the proper temperature is at all times retained. Heat is controlled by means of a rotary snap switch or an automatic control device, so that the desired temperature can always be had. The illustrations show a bench-type pot mounted on a hand truck and a portable pot, the latter being made in sizes ranging from 10 to 25 pounds.

PNEUMATIC TOOLS.—The Independent Pneumatic Tool Co., Chicago, has published a 78-page illustrated catalog in which it describes and illustrates pneumatic tools and electric drills which it manufactures. New additions to the company's line of products, which are described in this catalog, include, motor-driven air hoists; pneumatic sand rammers; universal vice for pneumatic drills; hose couplings; power screw driver, hose clamp and hose mender.

WELDING AND CUTTING.—The Oxweld Acetylene Co., Chicago, has issued a series of small printed pamphlets containing information of value to users of welding and cutting apparatus. The matter contained in the pamphlets was taken from the company's instruction book and catalog, and among the subjects are: Directions for operating lead burning equipment, and directions for operating welding equipment and directions for operating cutting equipment. Each pamphlet contains a detailed list of parts comprising the equipment treated.

FLANGED FITTINGS.—The Lynchburg Foundry Co., Lynchburg, Va., has issued its 1920 edition of its cast iron flanged pipe and fittings catalog. In this booklet the company has endeavored to compile as much data pertaining to flange piping material as possible. Lengthy and confusing details have been left out, it being understood that such details will be furnished upon request. The fittings described and listed in the catalog are made to conform to the American standard as recommended by the American Society of Mechanical Engineers.

HOLE DRILLS.—The Detroit Hexagon Drill Co., Detroit, has published an 18-page booklet in which angular hole drilling by the use of hexagon drills is described and illustrated. According to the booklet it is possible to drill a square or hexagon hole with the use of a hexagon drill, with no more trouble than that experienced in the drilling of round holes. The claim is made that to sink a blind hexagon or square hole ½ inch across the flats and 2 inches deep, without the use of a hexagon drill would require three hours work of a good mechanic, but that a similar job can be done in about six minutes, by using a hexagon drill, and the work will not be out more than .005 of an inch in any respect.

BEVEL GEAR GENERATOR.—An illustrated 4-page circular is being circulated by the Bilgrim Machine Works, Philadelphia, in which two sizes of bevel gear generators are described and illustrated. The first size will plane bevel wheels up to six inches in diameter with 1 inch pitch and 2½ inches face from mitre wheels to bevel wheels of proportion one to six. This machine occupies a floor space of 3-feet, 10-inches x 2-feet, 3-inches, while its gross weight is 2700 pounds. The other size described, will plane bevel wheels up to 16 inches in diameter, 2 inches pitch, 6 inches face from mitre wheels to bevel wheels of proportion one to four. This type of machine occupies a floor space, 6-feet 1-inch x 2-feet 8-inches and its gross weight is 6100 pounds.

OPTICAL PYROMETER.—The Rhode Laboratory Supply Co., New York, is circulating a 4-page leaflet in which an optical pyrometer for the measurement of high temperatures is described and illustrated. The instrument consists of a brass tube, furnished with a small achromatic telescope, so arranged that the objective of the telescope focuses the image of the heated body on a movable prism placed inside the tube. The eye-piece of the telescope then reveals the magnified image on the prism. A shield is provided to prevent exterior light reaching the eye. The prism is made of specially prepared dark glass, which is so arranged that it cuts off the light emitted by a heated body at different temperatures. According to the leaflet the pyrometer can be used whenever the object to be examined shows a distinct coloration for any temperature above 525 degrees Cent.

VERTICAL BORING MILL.—A 4-page illustrated folder has been published by the Gisholt Machine Co., Madison, Wis., in which a vertical boring and turning mill is described and illustrated. According to the folder, the driving mechanism is contained within the base of the machine and is driven by a 4-step cone pulley, which in connection with a 2-speed countershaft provides for 16 changes of table speeds in geometrical progression. The standard machine is equipped with a plain table. A foot brake enables the operator to have perfect control of the table after the power is thrown off. The turret head can be set at any angle within 30 degrees from vertical, either side of the center. Eight gear driven feeds are obtainable, and a micrometer index dial, reading in thousandths of an inch, facilitates the accurate setting of machine tools. Other details are given.

NEW OFFICES.—Rickard & Sloan, Inc., New York, have issued a booklet entitled "Trekking," in which the organization's new offices are described and in addition, a number of examples of the current advertising which it has done for its clients are shown. The booklet principally is devoted to describing the new offices, at 25 Spruce street, which have been laid out in such a way as to completely meet the needs of a high-class, specialized advertising business. The office is flooded with light from windows extending around three sides of the building. Noiseproof private offices are provided for the executives and creative staff. The arrangement of the general office is such as to enable an individual to be interviewed without disturbing others in the room. The photographic studio is complete. A line drawing, showing the layout of the various offices and departments is given, as is a line drawing of that part of New York City in which the offices are located. This shows the easy accessibility from street car lines, subway and railroad. A list of the organization's advertising clients are given, many of whom have been clients since the organization started business in 1912.